Aviation Week

Including Space Technology

A McGraw-Hill Publication

April 6, 1959

Inertial Guidance System Sales Show Fast Climb

Modified USAF X-17 Missile Launches Argus Experiment

Convair 880 and 600 Jet-liners

YEARS AHEAD FOR YEARS TO COME

The elegance of Convair's 880 and 600 Jet-Liners will set standards for luxury travel in the new jet age. Foremost in designing for jet-travel comforts, Convair *Human Engineering* experts have assisted in creating new concepts in color, lighting, and interior appointments. Every modern convenience, comfort, and luxury will be yours in Convair Jet-Liners—truly elegance that is *years ahead for years to come!*

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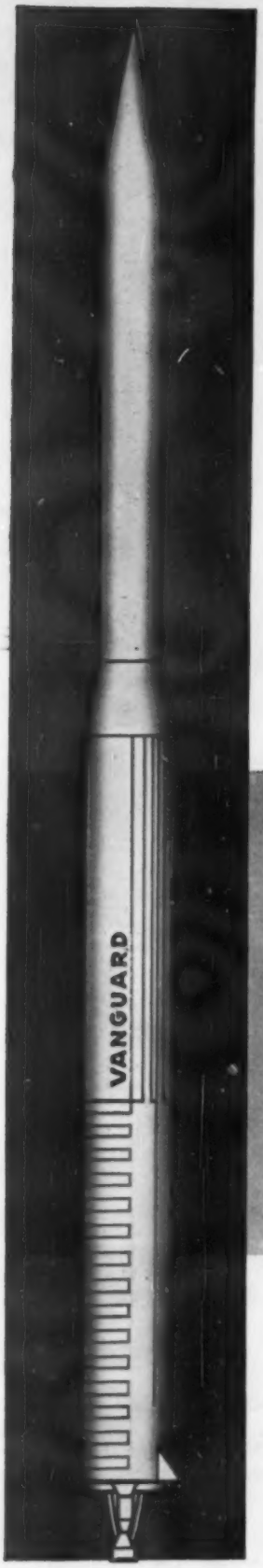
First to offer Convair 880 or 600 Jet-Liner service will be TWA, DELTA, TRANSCONTINENTAL (Argentina), REAL-AEROVIAS (Brazil), S.A.S., SWISSAIR, AMERICAN



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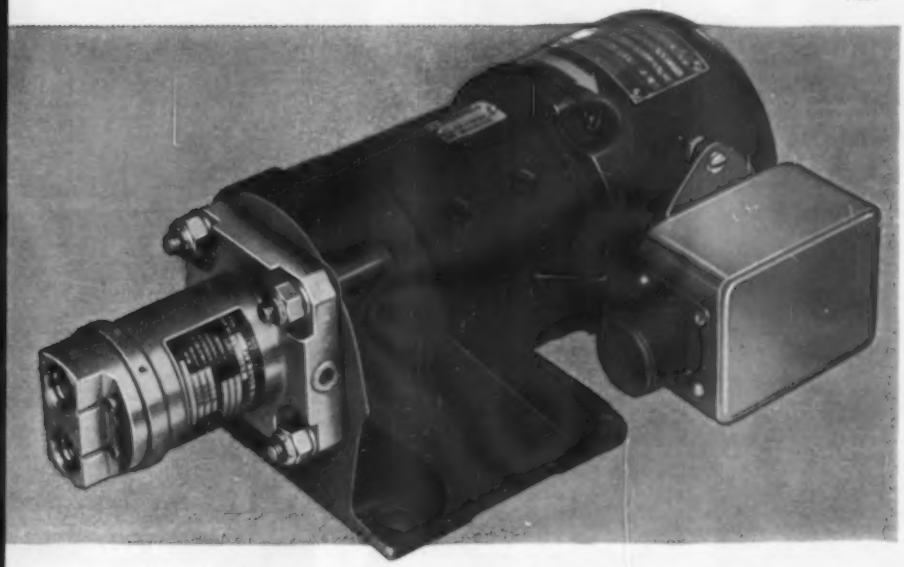
...for Vanguard Earth Satellite Rocket Vehicle

Numerous Vickers miniaturized hydraulic airborne components have been successfully developed for missile use without sacrifice of their inherent high efficiency and reliability. Representative of the "packaged" approach to dependable missile hydraulic power is the PFM-3906 constant displacement piston type pump shown here mounted on an electric motor. The pump has a theoretical delivery of 0.84 gpm at 7400 rpm and 1000 psi with a volumetric efficiency of 95%. The explosion proof motor has 6.0 in.-lb. torque from 6900 to 9000 rpm. The complete package weighs 8 lb. . . . 1 lb. for the hydraulic pump and 7 lb. for the electric motor. **The overall length is less than 10 inches.** For further information about Vickers miniaturized hydraulic components and complete packages, ask for Bulletin A-5216.

7886



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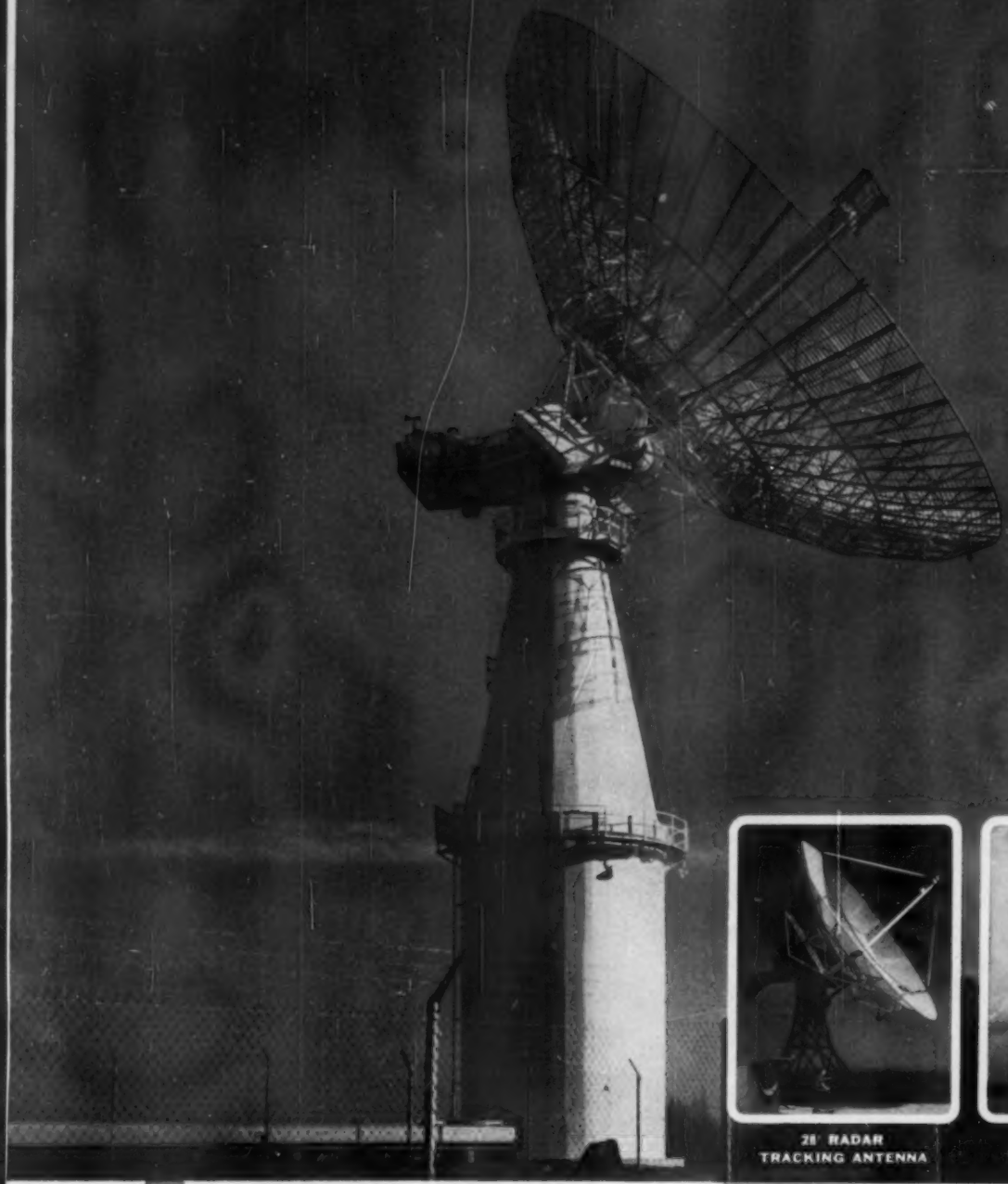
NEW 84′ KENNEDY TRACKING ANTENNA



28′ RADAR
TRACKING ANTENNA

60′ TELEMETRY
TRACKING ANTENNA

TOWERING 90 feet above the New England countryside at Westford, Mass., this giant 84′ tracking antenna is part of a new, long-range radar installation now studying problems in ballistics missile defense.

Equipped with an elevation-azimuth type mount designed and fabricated in cooperation with M. I. T.'s Lincoln Laboratory, the big dish can make a full 360° horizontal sweep and has a vertical rotating capability of 90°. Like all Kennedy steerable antennas, it features a light weight, aluminum dish supported by a steel pedestal mounted on a concrete base.

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AVIATION CALENDAR

Apr. 10—First Annual Lester D. Gardner Lecture on the History of Aeronautics, to be delivered by Grover Loening, Massachusetts Institute of Technology, Cambridge, Mass.

Apr. 12-19—Air Force Assn.'s World Congress of Flight, Las Vegas, Nev.

Apr. 15-17—Second Annual Symposium on Information and Decision Processes, Purdue University, Lafayette, Ind.

Apr. 16-17—17th Annual Meeting, Aeronautical Training Society, Desert Inn, Las Vegas, Nev.

Apr. 16-18—11th Annual Southwestern Institute of Radio Engineers Conference and Electronics Show, Dallas Memorial Auditorium, Dallas, Tex.

Apr. 20-24—Fourth Institute on Current Developments in Research Administration, American University, Washington, D. C. Sponsor: School of Government and Public Affairs.

Apr. 21-22—Spring Technical Conference on Electronic Data Processing, Cincinnati Section of the Institute of Radio Engineers, Engineering Society Bldg., Cincinnati, Ohio.

Apr. 21-23—Ninth Annual Convention, International Airline Navigators Council, Hotel Manhattan, New York, N. Y.

Apr. 22-24—1959 Annual Meeting, Institute of Environmental Engineers, LaSalle Hotel, Chicago, Ill.

Apr. 23—Annual Eastern Regional Meeting, Institute of Navigation, Friendship International Airport, Baltimore, Md.

Apr. 23-24—Quarterly Regional Meeting, Assn. of Local and Territorial Airlines, Bel Air Motor Hotel, St. Louis, Mo.

Apr. 27-29—13th Annual Meeting Aero Medical Assn., Statler Hilton Hotel, Los Angeles, Calif.

Apr. 29-May 1—First National Metals Engineering Conference, American Society of

(*Continued on page 6*)

AVIATION WEEK Including Space Technology

April 6, 1959

Vol. 70, No. 14

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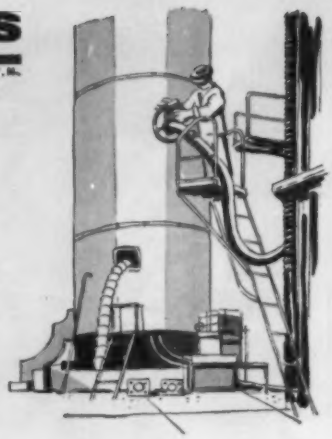

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The Quartector sensing element is a piezo-electric quartz crystal mounted in a probe or submersible sensor unit. Circuitry consists of a four stage transistor amplifier with a transistor detector circuit in the feedback loop, and an output control relay. When the crystal is in gas, it is free to vibrate at its natural frequency, and oscillation is sustained. When the crystal is submersed in liquid, however, its motion is damped, signal output drops, and the output control relay is de-energized.

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AVIATION CALENDAR

(*Continued from page 5*)

Mechanical Engineers, Hotel Sheraton-Ten Eyck, Albany, N. Y.

Apr. 30-May 1—Controllable Satellites Conference, American Rocket Society, Massachusetts Institute of Technology, Cambridge, Mass.

Apr. 30-May 1—Second Annual Meeting Aircraft Electronics Assn., McAllister Hotel, Miami, Fla.

May 3-7—Symposium on Electrode Processes, Phila, Pa. Sponsors: AFOSR/Chemistry Division and Electromechanical Society. (Contact Electrochemical Society, Inc., 1860 Broadway, N.Y.C.)

May 4-6—National Aeronautical Electronic Conference, Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio.

May 4-7—Fifth Annual Flight Test Instrumentation Symposium, sponsored by the Instrument Society of America, Seattle Section, Olympic Hotel, Seattle, Wash.

May 5-7—Annual Meeting, California Assn. of Airport Executives, Casa Munros Hotel, Monterey, Calif.

May 6-8—1959 Electronic Components Conference, Benjamin Franklin Hotel, Phila.

May 6-9—15th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 7-10—Annual Meeting, National Intercollegiate Flying Assn., University of Illinois' Airport, Champaign, Ill.

May 15-16—Spring Meeting, Society of Aircraft Materials and Process Engineers—Eastern Division, Hotel Statler, New York, N. Y.

May 18-21—18th Annual National Conference, Society of Aeronautical Weight Engineers, Hotel Henry Grady, Atlanta, Ga.

May 20-22—National Spring Meeting & Exhibition, Society for Experimental Stress Analysis, Sheraton Park Hotel, Washington, D. C.

May 20-22—Second Jet Age Airport Conference, American Society of Civil Engineers, Shamrock-Hilton Hotel, Houston, Tex.

May 21-22—1959 Ohio Valley Instrument and Automation Exhibit and Symposium, Cincinnati Section, Instrument Society of America, Music Hall, Cincinnati, Ohio.

May 24-June 5—Federation Aeronautique Internationale Annual Meeting, Moscow, USSR.

May 25-27—1959 National Telemetering Conference on Investigation of Space, Brown Palace and Cosmopolitan Hotel, Denver, Colo. Sponsors: American Rocket Society, Institute of the Aeronautical Sciences, American Institute of Electrical Engineers and Instrument Society of America.

May 26-28—Supersonic Transport Meeting, San Diego Section, Institute of the Aeronautical Sciences, San Diego, Calif.

June 8-11—Semi-annual Meeting and Astronautical Exhibition, American Rocket Society, El Cortez Hotel, San Diego, Calif.

June 12-21—23rd French International Air Show Le Bourget, Paris, France.

Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Space Technology Laboratories is responsible for the over-all systems engineering, technical direction and related research for the Air Force Intercontinental and Intermediate Range Ballistic Missile Programs and for the highly successful Thor-Able series of ICBM range re-entry launches. ■ In addition, STL carries out special experimental projects for such agencies as the National Aeronautics and Space Administration and the Advanced Research Projects Agency. On behalf of these agencies and in conjunction with the Air Force Ballistic Missile Division, STL designed and produced the Pioneer I payload, one of the most sophisticated fact-finding devices ever launched into space. In addition, STL provided systems engineering and technical direction for the Air Force satellite, the Atlas SCORE. ■ In support of these and future requirements, STL's activities provide a medium through which scientists and engineers are able to direct their interests and abilities towards the solution of complex space age problems. STL invites inquiries regarding staff openings in any of the five major areas of the company's activities.

Electronics Laboratory
...provides technical direction for, and conducts studies leading to, design and specifications of advanced guidance, control, and communication systems; also packaging, environmental testing and over-all checkout.

Physical Research Laboratory
...conducts basic research including analytical and experimental investigations in magnetohydrodynamics, thermonuclear power, plasma physics, and low temperature solid state physics.

Astrovehicles Laboratory
...conceives, evaluates, designs, develops, and tests space vehicle systems; provides technical direction of propulsion, nose cone, and airframe subsystems; explores new propulsion, airframe, re-entry, and ground handling techniques.

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...provides a centralized mathematical and computing facility and engages in advanced research in data systems, information theory, computation systems and automatic programming, systems and hardware simulation, and applied mathematics.

Systems Engineering Division
...has the over-all responsibility for the system integration of the Atlas, Titan, Thor, and Minuteman weapons systems, in addition to responsibility for technical direction of the airframe, sub-system, assembly and test, and ground support activities; evaluates proposed future weapons and space systems.

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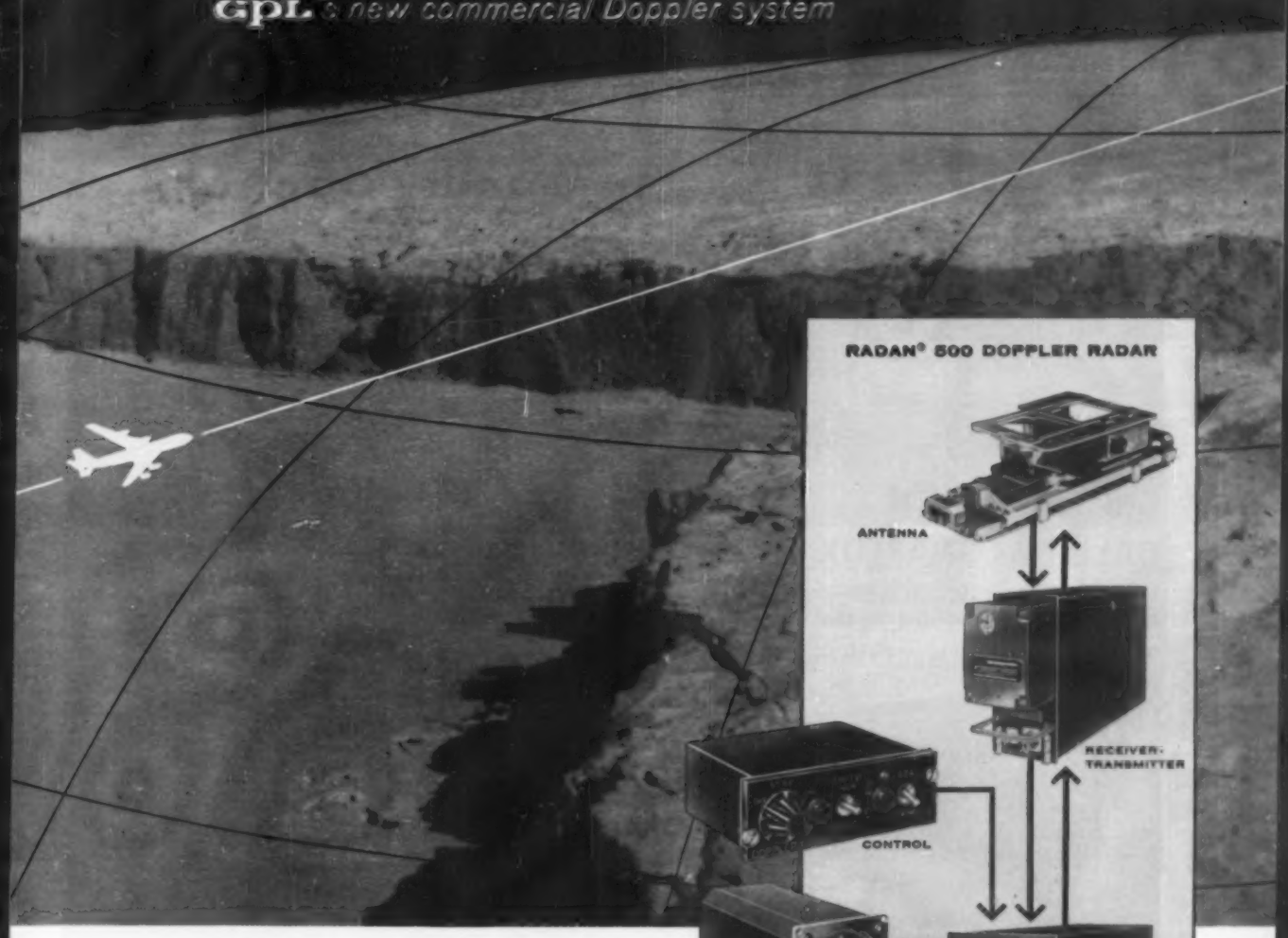
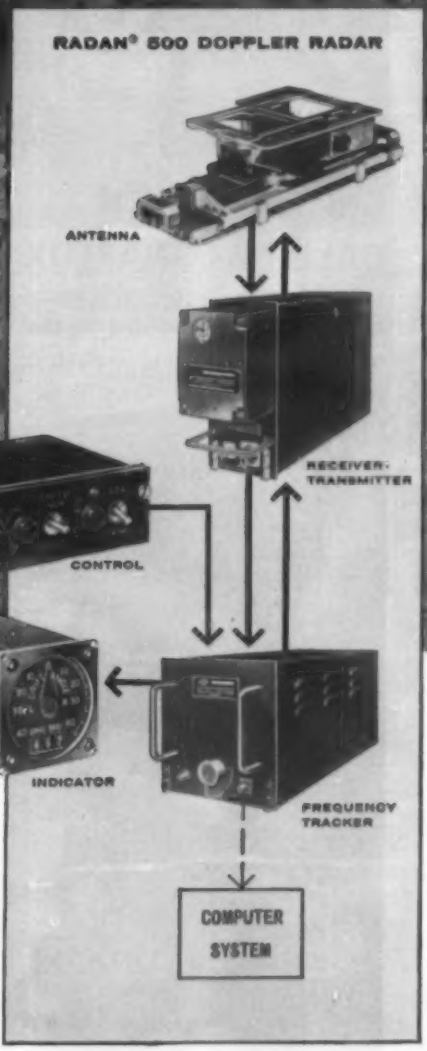
GPL's new commercial Doppler system





RADAN 500 Doppler radar, GPL's all new ARINC system for airlines, offers the reliability and longevity of service that only 13 years of direct Doppler experience can insure...reliability resulting from **flight-proven** designs based on 10 years of product improvement programs, service feedback on more than 1,500 operational GPL Doppler systems, and special attention to the design and maintenance philosophies of commercial airlines.

SELF-CONTAINED: Ground speed and drift angle, displayed directly, continuously, and accurately — over the poles, over oceans, over any terrain, day or night, good weather or bad — provide a dramatic extension of airline capabilities and important operational savings.

VERSATILE: Outputs for navigation computers, flight directors, autopilots, remote indicators, and attachments. Write to the world's most experienced Doppler manufacturer for further details on RADAN 500.

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assures metallurgical acceptability for the first time in the anti-friction bearing industry.

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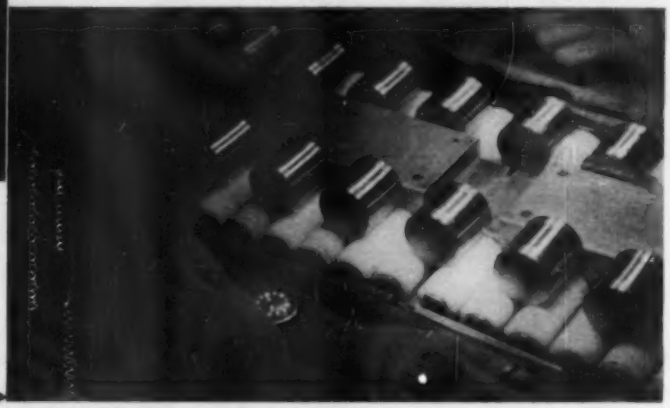
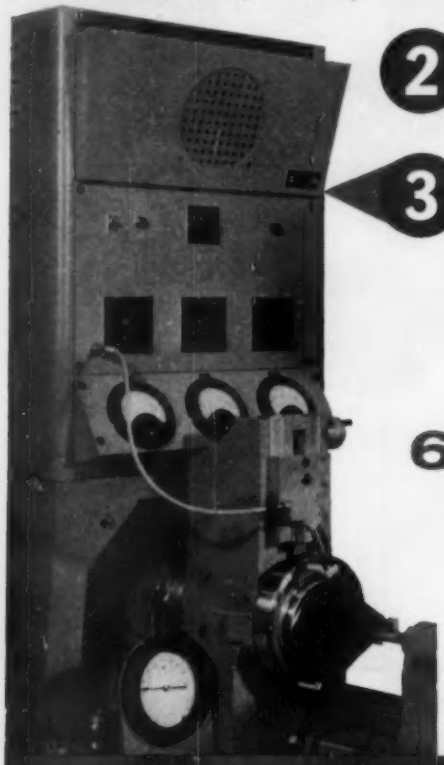


2

ROLL "MAGNAFLUX"
assures metallurgical perfection by automatic means.



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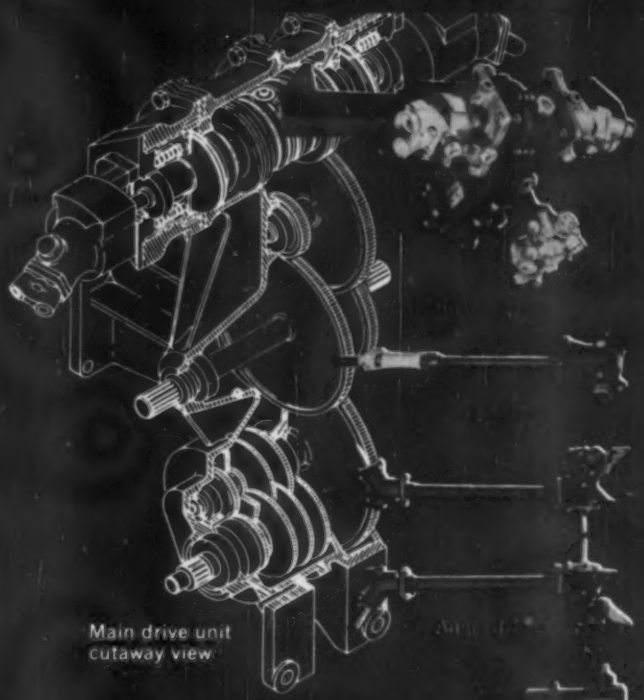
WESTERN GEAR *designs and builds wing flap control system for* CONVAIR 880



Main drive unit
cutaway view

The newly named Precision Products Division of Western Gear Corporation has launched an intensified program of developing systems for the aircraft industry. Stepped-up research, creative engineering, testing and manufacturing facilities put this division in the forefront of the nation's leading suppliers.

Most recent development is the wing flap control system for the Convair 880 jetliner. Western Gear carried the entire completely-integrated system through design, testing and fabrication, delivering the units shown here as well as torque tubes, driveshafts, motors and other components.

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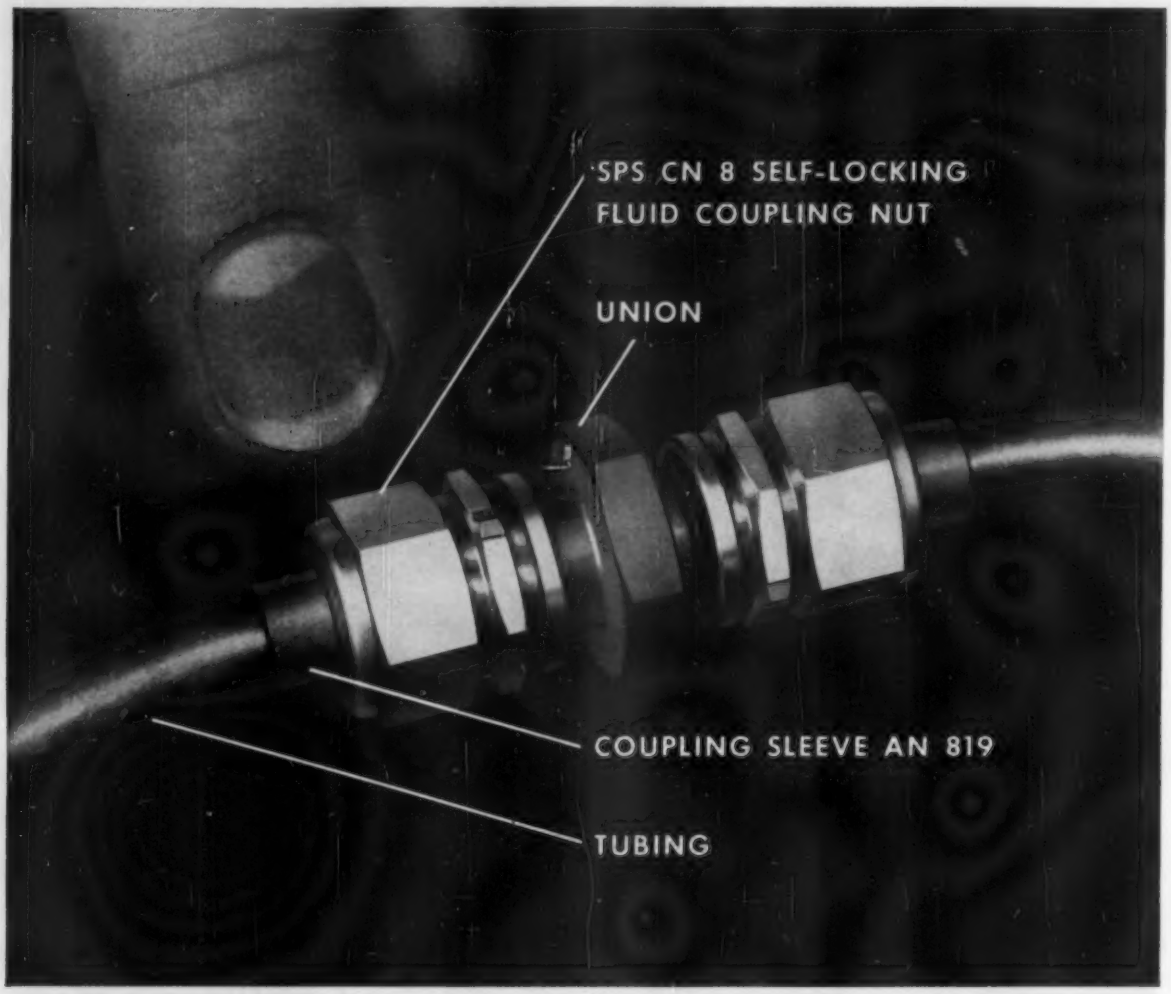
New from SPS Laboratories

CN 8...first self-locking coupling nut for fuel, hydraulic and oil lines



New free-starting, self-locking coupling nut insures vibration-proof tightness—and freedom from leaks caused by nut backoff—in fluid system line joints. And the self-contained locking action of this all-metal unit eliminates costly techniques in wiring to prevent loosening from vibration. Characteristics are given in Bulletin 2488. Write for a copy today. Aircraft/Missiles Division, STANDARD PRESSED STEEL Co., Jenkintown 3, Pa.

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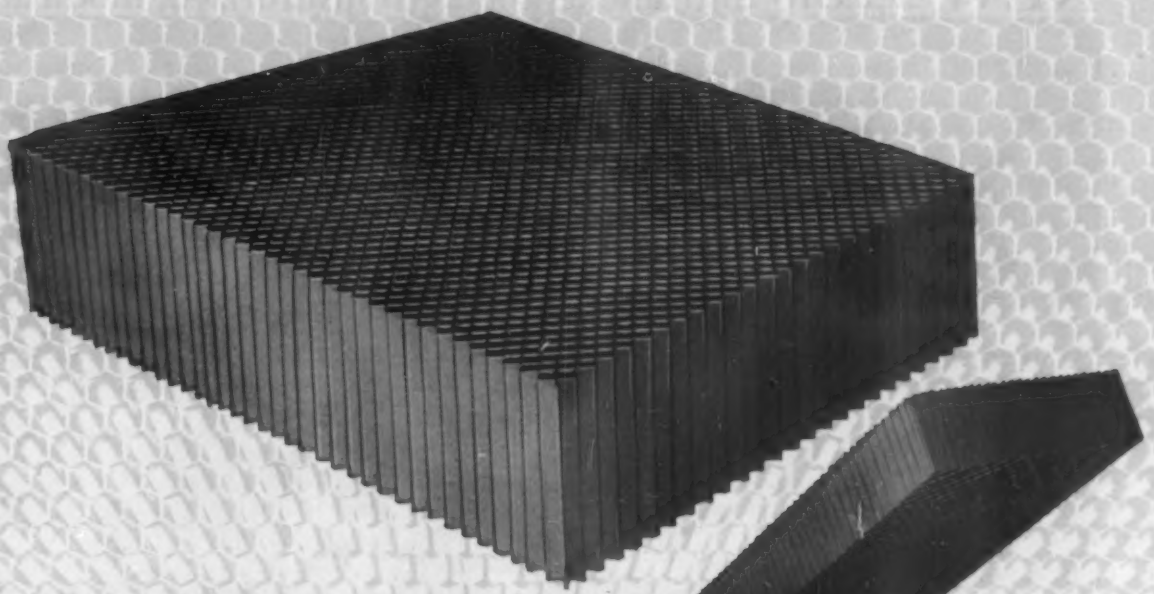
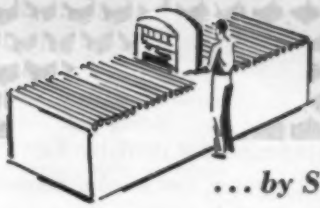


PROGRESS



... by Swedlow in the manufacture of high temperature welded honeycomb core is a major factor in the production and performance of advanced aircraft and missiles.

Swedlow's new precision automatic machines mean thicker, wider and longer blankets of honeycomb core with the added features of close tolerances, increased production and improved deliveries.

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From Swedlow's progressive research programs in methods and materials will come improved higher temperature welded honeycomb cores. Expert technical service is available from Swedlow's applications advisory group.

For full information, contact the Swedlow plant nearest you, or write for technical bulletin "High Temperature Welded Honeycomb Core." Please refer to Dept. 10.

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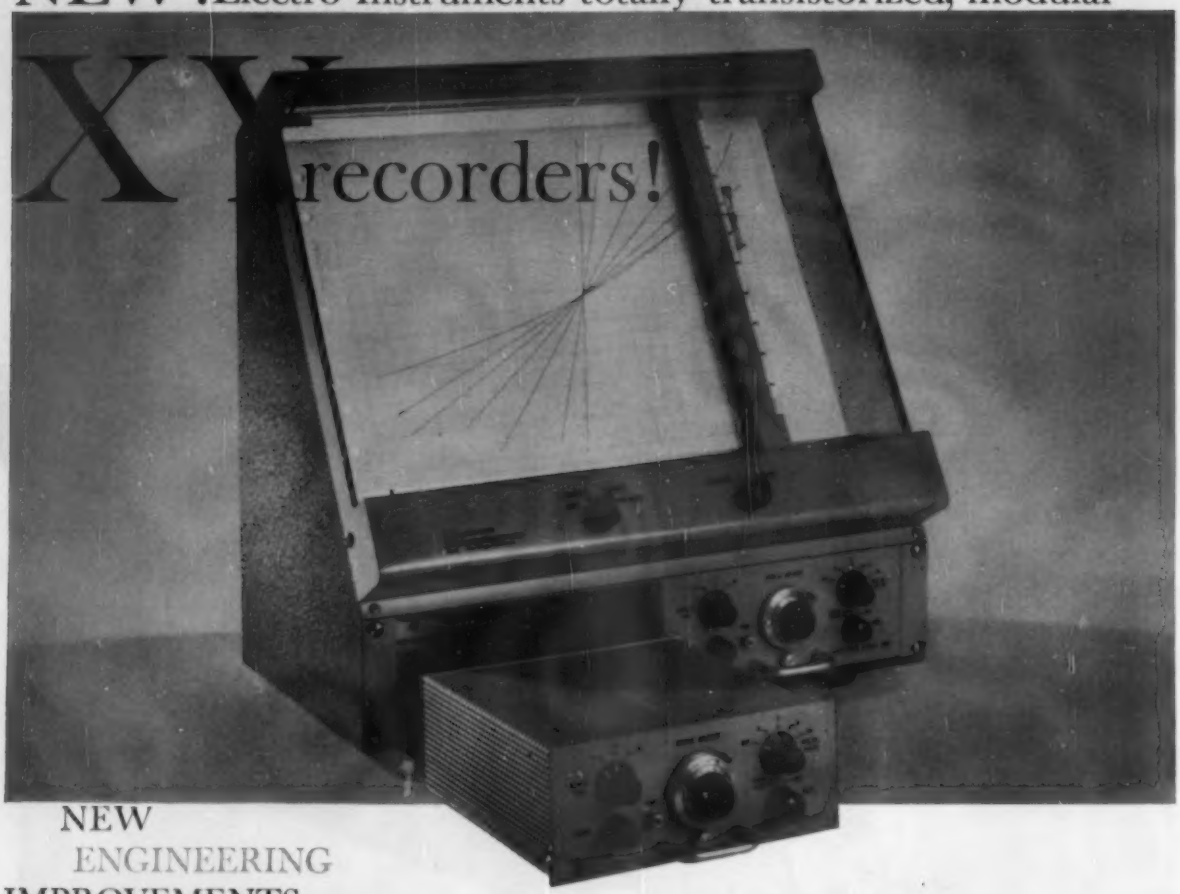
NEW! Electro Instruments totally-transistorized, modular XY recorders!



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- Faster slewing speeds—Pen: 30"/sec.; Carriage: 30"/sec.
- Greater accuracies—Static: 0.1%; Dynamic: 0.2%.
- 0.05% internal calibration.
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- Input function modules in rack mountable case can be removed from plotter for remote operation.
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One basic plotter with input modules available for general purpose, computer, low level differential, time base, curve following and other specialized functions.

	Model 410 Computer Module	Model 420 General Purpose Module	Model 430 Low Level Differential Module	Model 450 Curve Follower Module	Model 460 Time Base Module
Input	Single Ended	Single-Ended	Differential	Single-Ended	Single-Ended
Ranges	0.1, 1.0, 10v/in, calibrated vernier	16 steps, 1m v/in to 100 v/in, plus vernier	16 steps, 1m v/in to 100 v/in, plus vernier		0.1, 0.2, 0.3, 0.6, 1.0, 2.0 in/sec
Accuracy: Static Dynamic	±0.1% F/s ±0.2% F/s	±0.1% F/s ±0.2% F/s	±0.15% F/s ±0.2% F/s	±0.25% F/s	(time) ±1.0% F/s
Linearity				±0.1% F/s	(sweep) ±0.5% F/s
Input Resistance	2 megs, all ranges	1 meg to 3 megs Depending on range	1 meg to 3 megs Depending on range		
Zero Adjust	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset		
Reference	Internal Zener diode and external ±100v computer	Internal Zener diode	Internal Zener diode		Internal Zener diode
Calibration	Internal 0.1, 1.0, 10v Accurate to ±0.05%				
Common Mode Rejection			DC, 120 db AC, 100 db at 60 cps		
Max. Common Mode Voltage			50 v dc or peak ac		
Principle of Operation				60 cps magnetic induction	Electronic integration
Zero Drift				None	

Dimensions All Modules: 8½" W x 3½" H x 7¾" D

Model 400 Plotter

- **Recording Size:** 10" x 15"
- **Slewing Speed:** X, 40"/sec; Y, 30"/sec
- **Inputs:** X and Y inputs, and computer reference
- **Power:** 115 ±10 v, 60 cps
- **Dimensions:** 19" W x 19½" H x 11¾" D
- **Ambient Temperature Range:** 0-55°C
- **Controls:** Power off, standby, operate, pen; vacuum release; curve follower, amplifier; local, remote.

3540 Aero Court
San Diego 11, California

Electro Instruments, Inc.

Master Flight Reference

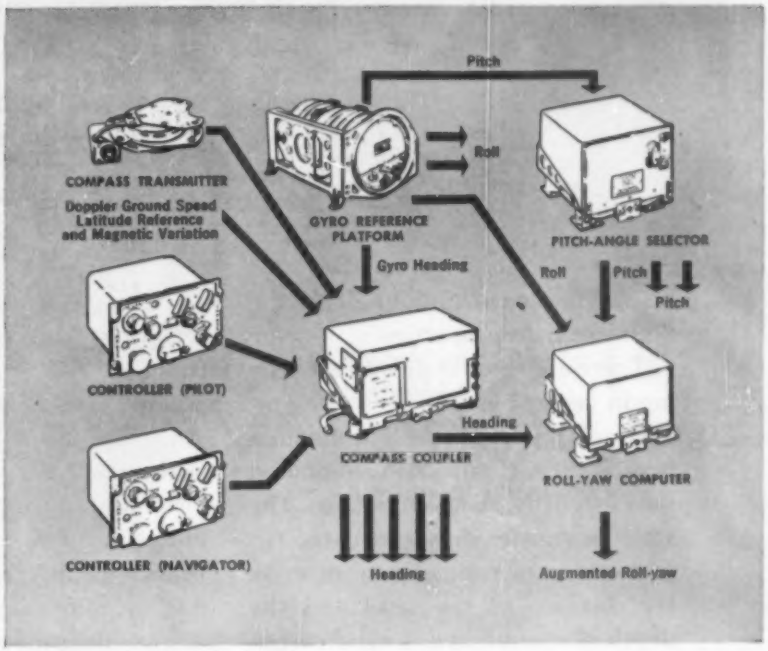
New General Electric Master Flight Reference System integrates direction and attitude changes; guides supersonic aircraft through intricate maneuvers such as over-the-shoulder and toss bombing

A new navigational sub-system, designed to help solve the problem of integrating the various elements of flight control at supersonic speeds, has been developed by the General Electric Instrument Department. Designated the SR-1 Master Flight Reference System, this electronic "brain" is already being used to guide some of our fastest jets in intricate maneuvers such as over-the-shoulder and toss bombing, Immelman turns, and cuban-eights.

Basically a direction and attitude reference sub-system, the General Electric SR-1 (Navy designation AN/ASN-26) accurately senses roll, pitch, and yaw change signals by means of three single-axis gyros. These changes are then converted into multiple signals and automatically relayed to aircraft radar, autopilot, dead-reckoning and navigational computers, bombing equipment, and all-attitude indicators.

General Electric engineers have designed the Master Flight Reference System around six basic components:

1. A three-gyro, four-gimbal, all-attitude stable platform from which flight reference information is transmitted.
2. A small remote compass transmitter which furnishes an accurate heading signal and is used in conjunction with the directional gyro platform to provide a stabilized heading direction.
3. A coupler device which receives the azimuth signal from the platform, plus any necessary correcting signals from the pilot, Doppler radar and the magnetic compass combining them to provide an accurate azimuth signal with sufficient outputs for the operation of the system.
4. A control panel located in the pilot's compartment for his use in setting in necessary information concerning mode of operation, aircraft ground speed, latitude, and synchronization of directional gyro and compass. An identical control panel may be installed for a navigator if required.
5. A servo adapter for platform pitch output which repeats platform-pitch signals for other aircraft components needing attitude information and capable of initiating the operation of any given function at a preset pitch angle.
6. A servo circuit which translates earth coordinates to aircraft coordinates during special maneuvers. It also provides true aircraft roll information for the autopilot and all-attitude indicator.



The Master Flight Reference System is just one of General Electric's many contributions to aircraft instrumentation. Other G-E aircraft instruments are used in systems that measure and indicate mass fuel-flow, engine speed, electric-quantities, temperature, and position. For information on any of these instrument systems, contact your nearest General Electric Apparatus Sales Office; or write direct to General Electric Co., Section 596-501, Schenectady 5, New York.

Mechanical, Electrical, Electronic Engineers . . .

If you would like to work on intriguing projects such as the Master Flight Reference System, there may be an unusual opportunity for you with the General Electric Instrument Department. For complete details, write or phone for an appointment with:

H. E. Crabtree, Manager—
Engineering Administration
Instrument Department
General Electric Company
40 Federal Street
West Lynn, Mass.

GENERAL ELECTRIC

XVIII

This is the eighteenth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Methods of Carburizing Alloy Steels

Carburizing is a means of impregnating the surface of steel with carbon, usually to very limited depths. Its purpose is to provide a hard, wear-resisting "case," or outer shell. Alloy steels, correctly handled, can be case-hardened without sacrificing desirable core properties.

There are three types of carburizing in general use:

Liquid Carburizing—The medium here is a hot salt bath composed basically of cyanide compounds. The steel is immersed in the bath, the period of immersion depending upon the analysis of the steel and the depth of case desired. Liquid carburizing is a convenient method of producing thin, hard, wear-resistant cases, generally within the depth range of 0.02 to 0.03 in. However, deeper cases may be obtained, the actual depths depending upon economics and end uses.

Gas Carburizing—This method employs a furnace in which a carbonaceous atmosphere is created; i.e., gases that are high in carbon components, or those containing carbon. Steel subjected to gas carburizing can be case-hardened to depths generally ranging from 0.01 to 0.04 in. When quenching takes place immediately after carburizing, distortion can be kept to a minimum.

Pack Carburizing—Where the pack method is used, the parts to be carburized are buried in a container of dry carbonaceous materials. The container is sealed tight to prevent the infiltration of air, placed in a furnace and kept there for eight hours or more, the actual time depending upon the depth of case desired. Pack carburizing is particularly suitable where a deep case is essential (0.06 in. and over), although medium cases in the 0.04-to-0.06-in. range are possible.

The carburizing of alloy steels is a highly technical subject, and Bethlehem metallurgists will be glad to help you with any phase of it. Feel free to consult with them about the results to be expected from various analyses and the various methods of treatment. And when you are in the market for alloy steels of any kind, please bear in mind that Bethlehem Steel makes the complete range of AISI standard grades of alloy steels, as well as special-analysis steels and all carbon grades.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

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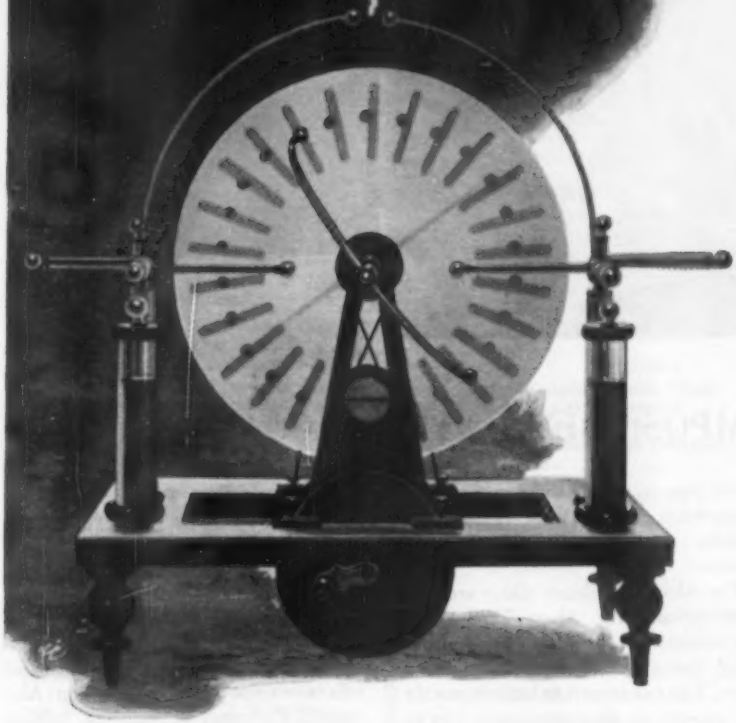
what is charge?



Earth's attraction for a lightning bolt?

+ or −, which is up?

A resonant phenomenon?

A singularity in a field?

What is the nuclear "glue" for like charges?

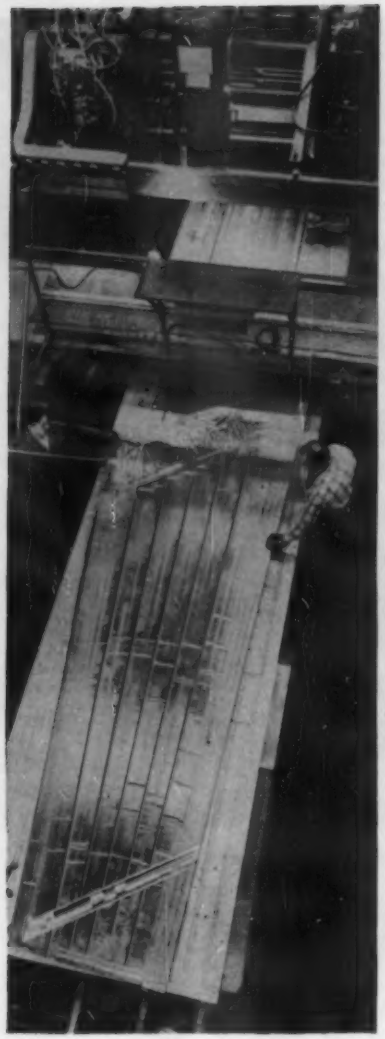
A better comprehension of charge is important to Allison because energy conversion is our business and charge is one keystone for this conversion work. Thus we have a deep and continuing interest in electrons, protons, positrons, neutrons, neutrinos—charge in all its forms.

In its investigations, Allison calls upon the capabilities within General Motors Corporation and its Divisions, as well as the specialized talents of other individuals and organizations. By applying this systems engineering concept to new research projects, we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

ALLISON

Division of General Motors, Indianapolis, Indiana



THEY CREATE THE IMPOSSIBLE—WITH ALCOA ALUMINUM

Not long ago, many of the components routinely turned out by the Franklin Balmar Corporation, of Baltimore, *would* have been quite impossible to fabricate—at *any* price.

They specialize in components of extreme intricacy—machined to precise tolerances. The components of the new Boeing B-52 wing, machined by Balmar as subcontractor for Fairchild Aircraft, are typical of the highly demanding work turned out by these precision "sculptors in aluminum."

Severe sculpturing can be performed satisfactorily only on aluminum of the highest quality. For this reason, Franklin Balmar must have top quality and dependable uniformity in the aluminum it uses. Alcoa has been able in all cases to satisfy these unusual requirements. This is why Alcoa® Aluminum is Franklin Balmar's first choice.

For Alcoa Aluminum alloys are predictably uniform. Alcoa 7178 alloy, for instance, in the wing panels of the B-52 fuel tank. Or any *other* Alcoa alloy. You can trust it to behave exactly the same, time after time. Once you've developed a production routine, you know it will produce identically reliable results continuously.

Another reason for Balmar's preference for Alcoa Aluminum is its high internal quality—an important consideration in work where the cost of machining may be many times the cost of the raw metal itself. A hidden flaw might ruin a piece *after* hundreds of dollars' worth of machining operations have been completed!

Preference for Alcoa Aluminum by Franklin Balmar Corporation is something—we hope—that should justify a similar preference on *your* part, when the need next arises. Contact our sales offices or write us for information: Aluminum Company of America, 2026-D Alcoa Building, Pittsburgh 19, Pa.

For Exciting Drama Watch "Alcoa Theatre," Alternate Mondays, NBC-TV, and "Alcoa Presents," Every Tuesday, ABC-TV

ALCOA ALUMINUM

Your Guide to the Best in Aluminum Value

April 6, 1959

Aviation Week

Including Space Technology

Vol. 70, No. 14
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Sun May Be Origin of Van Allen Radiation..... 26
▶U. S. lunar probe detects new intensity in belts; data indicates inner layer particles are protons.

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▶Nearly $250 million in inertial guidance systems was produced in U. S. last year; figure is expected to be 50% higher in 1959.

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COVER: Fired from the deck of the U. S. Navy experimental missile ship, USS Norton Sound, Project Argus test vehicle pushes an atomic device into space to produce a 100 mi. thick shell of electrons, trapped between magnetic layers out as far as 4,000 mi. Vehicle was a modified USAF Lockheed X-17 missile (AW Mar. 30, p. 26). For other Argus developments, see p. 31.

PICTURE CREDITS

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ANNOUNCING: NEW LIGHTWEIGHT B.F.GOODRICH DE-ICERS FOR YOUR PIPER APACHE

B.F.Goodrich Aviation Products announces a brand new, lightweight De-Icer system for the Piper Apache!

Providing the first practical, low cost ice protection ever developed for light aircraft, this new system contains no electrical connections. Weight, complete, is approximately 50 pounds—and nearly half of this weight can be removed easily for extra load capacity during summer flying.

The lightweight B.F.Goodrich Pneumatic De-Icer operates on compressed air which is stored in a compact, reinforced plastic accumulator. Guaranteed for 10,000 recharges at 3,000 psi, the accumulator provides enough energy for 7 hours of positive de-icing action with each full charge when operated on a 3-minute cycle.

The system performs satisfactorily between -65°F. and 200°F. Cycle and time life is the same as for the regular B.F.Goodrich De-Icers used on larger aircraft.

A complete kit, fully FAA-approved, is now available for the Piper Apache. Contact your local B.F.Goodrich Aviation Products distributor and see how easily you can have your own Piper Apache equipped with this low cost ice protection. Or write: *B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. AW-49, Akron, Ohio.*

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EDITORIAL

Business Flying's Future

One of the brightest spots in the entire aviation spectrum is the current growth and future prospects of the wide variety of flight operations lumped under the general classification of business flying. The solid expansion in this area during the past five years has proved that post-war prognosticators covering this subject were right for the wrong reasons. Post-war private flying did mushroom although neither at the time nor in the manner so widely predicted 15 years ago.

This growth did not begin its significant surge in 1946 on the crest of returning war veterans anxious to buy a low-priced "flivver plane" for fun, instead of a second automobile. Instead it started upward in the early 1950s with the introduction of the light twin-engine aircraft with a sales tag ranging from $32,000 up. Its primary customers have been business men—ranchers, salesmen, oil operators, doctors, etc., who have an economic need for readily available fast transportation.

Present Stature

The present stature of business flying was well detailed by Erwin J. Bulban, AVIATION WEEK Business Flying editor, in our Mar. 9 issue (p. 249). The benchmarks located there are truly astonishing and worth repeating. A total of 6,416 new private planes sold during 1958 for a retail billing of over $135 million-plus—just about four times the market of only five years ago. Business pilots logged 5.3 million hours in the air during 1958. This represents a growth of 150% in the past decade, accounts for about 50% of all time in the air and is 1.5 million more hours than the scheduled airlines of the U.S. flew in the same year. In addition, the volume of fixed base operations serving this field now is running at about $500 million annually.

All of this has been achieved by some radical departures from prior tradition in virtually every segment of this business—from technical design to financing and sales. The manufacturers have made a good start in building solid sales techniques to make it more attractive and economically feasible for larger segments of the American people to fly their own planes. They are providing dealers and salesmen with better sales tools and guidance, borrowing many of the automobile industry's proven techniques for clinching sales, and recognizing the need for tightening standards for its dealers, including attractive quarters, adequate number of demonstration planes, technically sound service features and financial responsibility. They have also developed more modern financing methods for both customers and dealers with one manufacturer's financial subsidiary financing over $11 million worth of new aircraft alone during 1958 and over $30 million since its organization only three years ago.

Future prospects for this continued steep growth curve appear to be bright. Federal Aviation Agency Administrator E. R. Quesada has been informed by manufacturers that business flying aircraft sales will total a billion dollars in the next five years. Instruction flying, which was sagging badly only a few years ago, is climbing back up the growth curve and increased from 1.3 million hours in 1957 to 1.9 million hours for last year. The annual fixed base operations bill will probably double to a billion dollar annual rate by 1962 and close to $100 million will be spent on research and development for improved performance aircraft for the business flying field.

FAA Recognition

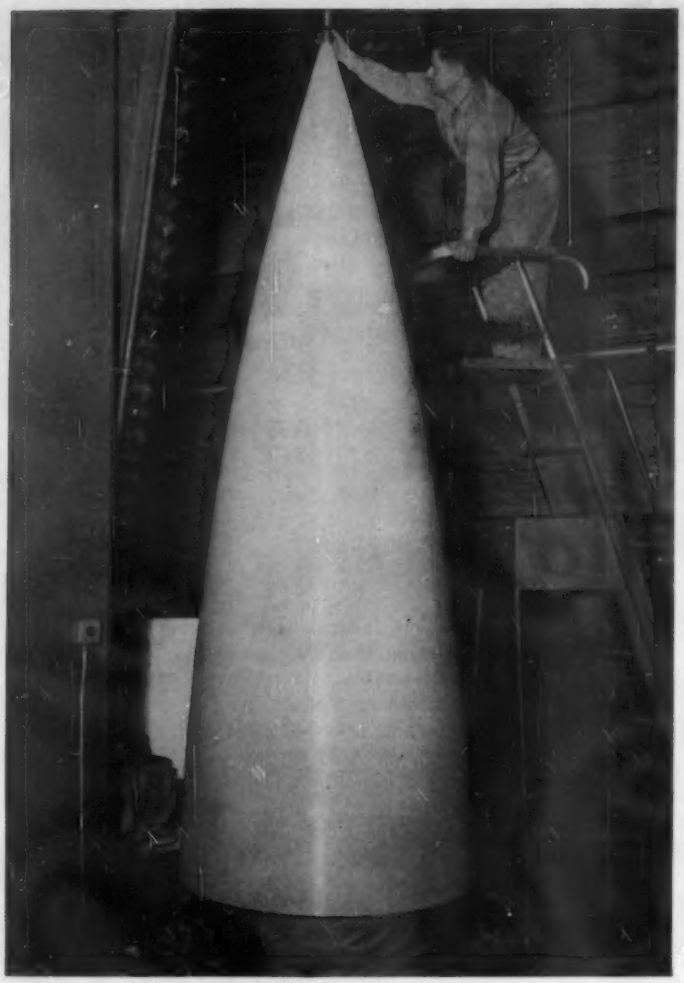
We have also noticed a growing recognition of the importance of this area by the new Federal Aviation Agency. The FAA staff handling the business flying field has been increased and broken down into specialists for each of its varied segments. The FAA-sponsored fly-in to its National Aviation Facilities Experimental Center at Atlantic City scheduled for May 9 is another indication that this agency plans to devote proper emphasis to this area. We also note that the Air Force is promoting private flying. For example, Strategic Air Command now has private flying clubs at 50 military bases with a total membership of 3,500 military and civilian personnel. The flying club at SAC headquarters now has 17 civil planes and expects to log 8,000 hr. this year.

Nor is business flying activity concentrated solely in the wide open airspaces of Texas and California, although these areas offer some of the greatest economic use for private aircraft. In the heavy traffic density of the New York terminal area, LaGuardia Field recorded 39,536 private and corporate aircraft movements in 1958; Newark tallied 20,316 and Idlewild 10,636. All of this was in addition to the 91,856 recorded at Teterboro which is designated as the major center for this type traffic in the New York area.

Growth Poses Problems

This continued growth of business flying poses important problems for all elements concerned—manufacturers, federal agencies, pilots and owners. As the business aircraft gains greater utility and performance, pilot standards must be improved commensurately. Proficiency with new navigation and flight control instruments will become a necessity instead of a professional luxury. Fixed base operators must provide better facilities to handle the servicing and maintenance of the growing private aircraft fleet. Manufacturers must provide continuously improving reliability, performance and safety features in their designs. And the government groups concerned with safety regulation, airport construction and financing, design and operation of airways and traffic control systems must consider the growing requirements of this business flying field and assure it adequate consideration in the over-all spectrum of aviation activities.

—Robert Hotz



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Walter Kidde & Company has available complete facilities and personnel for the development, testing and production of fiberglass forms. If you have a problem in this area – write Kidde today. We've solved some pretty tough ones in the last thirty years!

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FIBERGLASS FORMS ARE A KIDDE SPECIALTY!

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For the engineer interested in the field of pneumatics, filament-wound fiberglass spheres offer the solution to many problems. Available in capacities of from 50 to 2500 cubic inches these spheres can withstand pressures up to 5000 psi.

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WHO'S WHERE

In the Front Office

Charles A. Rheinstrom, board chairman, Helio Aircraft Corp., Norwood, Mass. Mr. Rheinstrom is executive vice president-sales for American Airlines, Inc.

J. A. R. Kay succeeds **Sir Roy Dobson** as managing director of A. V. Roe and Co., Ltd., subsidiary of the Hawker Siddeley Group, Ltd., London, England; **S. G. Joy** succeeds Mr. Kay as general manager of A. V. Roe. As managing director of the Hawker Siddeley Group, Sir Roy will concentrate on activities of the entire group.

Donald A. MacRitchie, president, Artisan Metal Works Co., Cleveland, Ohio.

Dr. John T. Bolljahn, executive vice president, Granger Associates, Palo Alto, Calif.

N. E. Halaby, executive vice president, Servomechanisms, Inc., Hawthorne, Calif.

Monson H. Hayes, vice president-research, development and engineering, Link Aviation, Inc., Binghamton, N. Y.

Jack F. Lepre, vice president-industrial relations and special projects, Reeves Instrument Corp., subsidiary of Dynamics Corporation of America, Garden City, N. Y.

B. R. Teree, vice president-engineering, Republic Manufacturing Co., Cleveland.

Donald H. Menzel, vice president, Geophysics Corporation of America, Boston, Mass., and head of the newly formed Astronomics Division.

Stephen B. Elggren and **Terence M. Nolan,** assistant vice presidents, Bell Aircraft Corp., Buffalo, N. Y. Mr. Elggren is sales manager and Mr. Nolan works manager of Bell's Niagara Frontier Division.

Dr. George B. Kistiakowsky, of Harvard University, has been named to the scientific directorate of United Research Corp., Menlo Park, Calif., subsidiary of United Aircraft Corp.

Dr. Alexander H. Flax, vice president-technical director, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.

Honors and Elections

Marcel Dassault, French aircraft designer, has received The Royal Aeronautical Society's Gold Medal for "his outstanding contributions to the design and development of aircraft."

William Littlewood, American Airlines' vice president-equipment development, has been appointed chairman of the National Aeronautics and Space Administration's Research Advisory Committee on Aircraft Operating Problems.

Changes

Dr. Adolph K. Thiel, program director for space missions, Space Technology Laboratories, Inc., Los Angeles, Calif. Dr. Thiel was formerly director of STL's Thor Program Office. Also: **Walter B. Brewer,** associate manager, Airborne Systems and Test Department, STL's Atlas Program Office.

Dr. Alden H. Ryan, manager, General Electric's Microwave Laboratory, Palo Alto, Calif.

(Continued on page 128)

INDUSTRY OBSERVER

► Radio Corp. of America has proposed a novel telescoping configuration for an air-launched ballistic missile which can be carried internally by the North American B-70 in Air Force's WS-138A competition. Proposal brings the total number of bidders in the competition to 13. RCA proposal calls for a hybrid guidance system using inertial elements but one which can be monitored and corrected in flight.

► Air Force's Dyna-Soar reorientation from an operational orbital weapon system to an exploratory prototype test vehicle includes elimination of the engine. Vehicle now will be an unpowered glider, boosted to near satellite speeds and altitudes.

► Rough timetable for the availability of new engines under National Aeronautics and Space Administration's national space rocket program is mid-1960 for the 6,000-lb.-thrust storable engine being developed by Jet Propulsion Laboratory; first month or so of 1961 for the 15,000-lb.-thrust liquid oxygen-hydrogen engine being developed by Pratt & Whitney, which will be coupled to form a double-barreled second stage for the Centaur vehicle; first quarter of 1963 for the 80,000-lb.-thrust liquid oxygen-hydrogen engine under study; mid-1963 for the second 20,000-lb.-thrust storable engine now under study; end of 1963 for the 1.5 million-lb.-thrust single chamber engine under development by Rocketdyne.

► Next Army satellite will combine four experiments originally scheduled for Vanguard project but left without launching vehicles due to unsuccessful Vanguard launchings. Army satellite also will carry a few silicon solar cells without the quartz windows currently used to protect against micrometeorites to determine if the cells can operate satisfactorily without heavy shields which also reduce the amount of electric power generated.

► One circuit of Navy's Communication Moon Relay is scheduled to go into operation this year linking Washington with Pearl Harbor. System uses the moon as a passive relay. It is now in test and evaluation stage and is expected to provide greater reliability and anti-jamming capability.

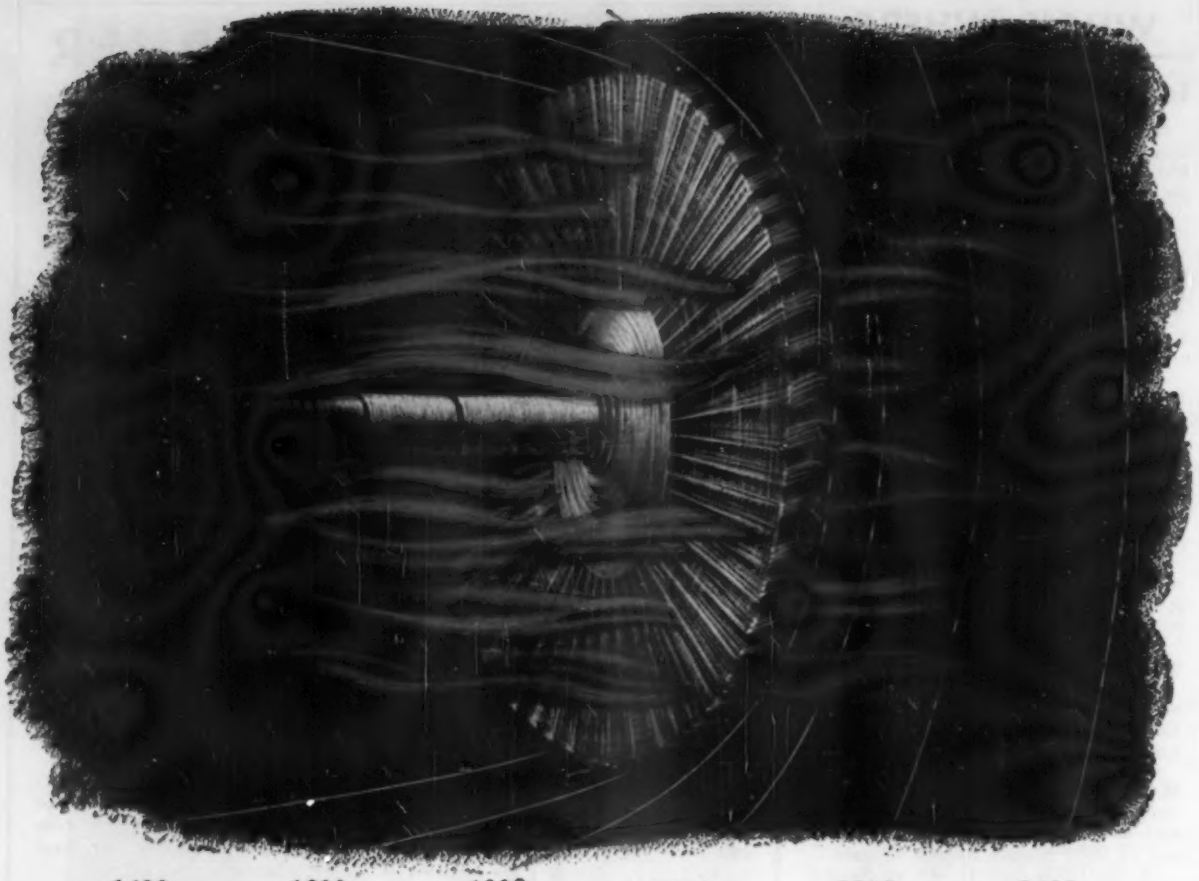
► Polaris fleet ballistic missile launching system may be installed aboard the Long Beach, Navy's first nuclear-powered guided missile cruiser. Funds for Polaris installations on this and other surface ships may be included in the Fiscal 1961 budget requests, depending partially upon results of launching tests from the surface test ship Observation Island.

► Despite a delay in Polaris test firings, Navy considers that the first three full-scale flight test vehicles have demonstrated flight acceptability of the solid propellant and of the flight separation system. Twenty-one of the 25 flight test vehicles that had been fired up to the beginning of this year were considered unqualified successes. Failures in the first two full-scale flights were reportedly due to elements that will not become part of the operational missile. First failure involved the destruct system, the second a flight programer. Cause of the third failure is undetermined. Current delay in tests is due largely to high temperature problems that are affecting the directional control system.

► Navy's ASROC ship-based missile anti-submarine system is expected to be ready for service test in early Fiscal 1960.

► Air Force Fiscal 1960 aircraft procurement program includes 70 Boeing B-52H bombers. B-52H is an improved-range version of the B-52 to be powered by Pratt & Whitney J57 turbofan engines. Air Force also plans to buy 96 Boeing KC-135 jet tankers during the year.

► Army plans to purchase seven de Havilland Caribou short takeoff and landing transports in Fiscal 1960 for operational and organizational tests. If Army buys the Caribou in quantity, the aircraft will be employed in tactical transport companies of 16 planes each with one company assigned to each Army and each Army corps.



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Washington Roundup

Nuclear-Plane Query

Rep. Melvin Price (D.-Ill.), chairman of the research and development subcommittee of the Joint Congressional Atomic Energy Committee and an ardent proponent for pushing ahead with the U. S. nuclear-powered plane program, is planning an inspection tour of the General Electric nuclear propulsion project at Evendale, Ohio, in an effort to find out just how soon this country could put an atomic plane into the air. Defense Department also is expected to participate—its delegation headed by Deputy Secretary Donald Quarles, a long-time advocate of the "go-slow" approach.

Proficiency Flying Cut

Under pressure from Congress and the White House to economize, Department of Defense is tightening up on pay for "proficiency" flying by desk officers, as predicted by AVIATION WEEK on Feb. 23 (p. 25). Policies issued by the Department last week direct that such flying "be closely controlled to ensure that the services get the maximum effectiveness for each dollar expended." They provide:

- **Annual review of requirements** for flying officers and assignment of these officers to positions where their aeronautical skills and knowledge will be more effectively employed.
- **Reduction in total flying activity** by crediting administrative and support flying as proficiency training. Previously such flights were credited as flying time, but not as proficiency training.
- **Annual screening to remove** from active flying status personnel who can no longer be expected to fill positions requiring a rated officer.

New Cargo Plane

Meanwhile, Air Transport Assn. officials and technicians plan sessions with members of the Senate Commerce Committee later this month to discuss Sen. Mike Monroney's (D.-Okla.) proposal for a $1 billion investment for a fleet of 400 efficient cargo aircraft for military airlift and commercial reserve. Monroney, chairman of the Aviation Subcommittee, is vigorously pushing the proposal. Monroney suggests that 100 of the all-cargo craft go to the Military Air Transport Service and 300 to commercial carriers to be available for military airlift on a few hours' notice.

Renegotiation Hearings

House Ways and Means Committee will start hearings on extension of the Renegotiation Act on April 27 with testimony by Renegotiation Board and Department of Defense officials. In a letter to committee chairman Rep. Wilbur Mills (D.-Ark.), Deputy Defense Secretary Donald Quarles says Defense wants:

- **To extend the law for two years** and three months—from the present expiration date of June 30, 1959, to Sept. 30, 1961. In the rapidly advancing aircraft, missile, and space fields, Quarles says, there is no past production and cost experience to assure against excessive profits. "Experience has shown that the renegotiation authority is an effective method."
- **To authorize the appeal of** renegotiation rulings of the U. S. Tax Court to the Court of Appeals. Aircraft manufacturers urged this last year.
- **To require the Renegotiation Board** to give "due consideration" to the pricing provisions of incentive type contracts. A major complaint of aircraft companies is that the Renegotiation Board makes incentive-type contracts meaningless by recapturing incentive earnings.
- **To require Renegotiation Board** in its determinations to specifically inform the contractor as to the consideration and recognition it has given to each of the numerous factors listed in the law—reasonableness of costs and profits with regard to volume of production, private capital investment, extent of risk, inventive and developmental contribution, etc.

In Congress

Other Capitol Hill developments include:

- **Weapon systems.** House Armed Services Investigating Subcommittee headed by Rep. Edward Hebert (D.-La.) will begin its evaluation of weapon system procurement on April 13 with testimony from J. L. Atwood, president of North American Aviation, Inc. Atwood will be followed by Courtlandt Gross, president of Lockheed Aircraft Corp.
- **Missile management.** House Military Operations Subcommittee headed by Rep. Chet Holifield (D.-Calif.) has canceled hearings with missile contractors originally scheduled to begin today and is proceeding to write a report weighing Army's "in-house" missile management against management of USAF's program by Space Technology Laboratories (AW Mar. 23, p. 34). The subcommittee staff has interviewed several contractors, including Convair, Lockheed Aircraft Corp., Aerojet-General Corp., and the Rocketdyne Division of North American Aviation.
- **MATS.** The Holifield subcommittee also is scheduling a hearing on Military Air Transport Service for the first week of May. The subcommittee has criticized MATS for developing services competitive with commercial operators.
- **Federal Aviation Agency.** House Information Subcommittee headed by Rep. John Moss (D.-Calif.), is investigating charges that Federal Aviation Agency has suppressed reports on difficulties encountered with the new type altimeter installed in Lockheed Electra turboprop and Boeing 707-120 jet transports.
- **Procurement legislation.** Senate Armed Services Committee is expected to establish a subcommittee shortly to consider legislation sponsored by Sen. Leverett Saltonstall (R.-Mass.) making extensive changes in procurement laws aimed at cutting lead time in new military weapons development (AW Aug. 18, p. 26).

Navigation Dispute Lingers

Despite International Civil Aviation Organization decision to adopt VOR/DME-T as the international navigational system in preference to the British Commonwealth sponsored Decca system (AW Mar. 2, p. 24), the British can be expected to wage a rear-guard battle in favor of Decca. The controversial issue was placed on the agenda covering last month's meeting here between President Eisenhower and Prime Minister Harold MacMillan but was later removed on the recommendation of the Federal Aviation Agency. FAA Administrator Elwood Quesada, who has canceled two trips to England in the past six months—including the November trip with Vice President Nixon—is now definitely planning to visit Britain within the near future. **—Washington staff**

Sun May Be Origin of Van Allen Radiation

U. S. lunar probe detects new intensity in belts; data indicates inner layer particles are protons.

By Evert Clark

Washington—Pioneer IV lunar probe, launched after five days of intense solar activity, has shown "almost conclusively" that the sun is the origin of the charged particles trapped in the outermost Van Allen layer by the earth's magnetic field.

The probe detected radiation 2 to 10 times as intense as that measured by Pioneer III and found the peak of intensity to be 10,000 to 15,000 km. farther out from the earth than the peak measured three months earlier by Pioneer III.

Origin of the particles in the inner Van Allen layer is still in dispute but "a very ingenious post mortem analysis" of the Explorer IV satellite's flight by the Van Allen group has led to the conclusion that the energetic particles in this inner layer definitely are protons.

These, and a number of other details concerning the two belts of particles spiraling along the magnetic lines of force that surround the earth, were disclosed following a two-day seminar sponsored by the National Aeronautics and Space Administration's Theoretical Division. Formal presentations on the properties of the radiation belts and their geophysical significance will be made at a joint National Academy of Sciences-NASA-American Physical Society Symposium here on April 27-29.

Other highlights disclosed at a press conference that followed the seminar:

• **"Solar Van Allen belt"** of particles trapped by the sun's magnetic field and occasionally expelled toward earth may explain the origin of the particles found in the outer layer near earth, according to Prof. Thomas Gold of Harvard University. It also may explain the paradox of "the very long times it seems to take the particles to reach the earth as compared to the velocities of energies that we know that these particles have when they get here." Gold also believes that some process similar to convection processes in the earth's atmosphere might help explain how the inner Van Allen radiation layer is formed.

• **"Most important result"** from the Argus high-altitude nuclear burst experiments (AW Mar. 30, p. 26), according to Prof. Nicholas Christofilos of the University of California, the man who proposed them, "was that for several weeks the belt, the thin layer, this hundred miles or so layer (of electrons injected by nuclear explosions) stayed in the same place without moving but maybe 10 or 20 mi., which means if there are such convection currents, these currents will take a year to go from the outer to the inner belt, which is of the order of the inner belt lifetime." The Argus layer lay between the inner and outer Van Allen belts.

• **Dr. Robert Jastrow**, head of NASA's Theoretical Division, said "you can feed particles into the radiation layer at a very slow rate, but because they stay there so long the population of particles in the layer can build up to very substantial values. And that is the key to the formation of the radiation layer.

"The estimates of the lifetime (of a particular particle within the layer) depend on altitude, and (they) range from seconds at a few hundred kilometers to years out at a thousand kilometers." Jastrow said the estimates go as high as "many" years, "meaning one to 10, or something like that." This will be discussed further at the April symposium. Particles injected by the Argus explosions must be discussed separately, because "they were not fed into the best place for long storage," but were "fed in at rather low levels," Prof. Gold said.

• **Inner belt's origin** may be solar, as Gold and Jastrow are inclined to believe, or as a result of the beta decay of neutrons into protons and electrons, as Dr. S. Fred Singer of Maryland University and Christofilos are inclined to believe. Christofilos said he has not excluded the possibility of "very dense jets coming from solar particles." Those who attended the seminar believed that beta decay hypothesis could be excluded as far as outer belt is concerned.

• **"Presence of a minimum** between the peaks of the two belts seemed to conference participants to be very difficult to understand," Jastrow said. "In other words, you can understand that there is a large concentration of particles fed by the sun, let us say. You can understand that there are particles at lower altitudes fed by beta decay or other means. But you can not on any clear mechanism understand why one belt is not merged into the other, but why there should be a gap instead." One suggestion was that an irregularity in the magnetic field over South Africa is so located that it might account for the gap "because the particles . . . when they come to this hole over South Africa, fall into it. They descend into somewhat lower altitudes than they would if the field were perfectly smooth. At lower altitudes they hit more air and they get taken out of the radiation layer."

• **Space vehicle, traveling** at the time of an effective solar outburst, "might see a great intensity of flux, not only the captured flux in the earth's field, but far out, far away," Gold said. This would be the case if the sun's magnetic field is focused out in space beyond the earth, and the earth happens to pass through a part of the field, as Gold believes probable. The intensity

Anti-ICBM Study

Advanced Research Projects Agency is sponsoring an industry competition designed to find new approaches that can be exploited during the next 10-15 years in destroying incoming ICBMs. Study contracts, totaling about $9 million, may be awarded to several firms with different approaches to the problem by the end of the month (AW Mar. 2, p. 18).

USAF Drops XF-109

Washington—Air Force has withdrawn its support from the XF-109 Mach 2 jet VTOL fighter program developed by Bell Aircraft Corp. because of lack of funds. Navy previously had been forced to withdraw from the program (AW Mar. 9, p. 79).

Earlier this year, Bell teamed with Convair to form a joint weapon systems management team to push development of the program (AW Feb. 9, p. 23). The two companies may continue development of the XF-109 with joint corporate funds in hopes of finding a new market for the aircraft. Artist's conception of the plane, whose earlier designation was D-188A, was published in the Jan. 5 issue of Aviation Week (p. 23).

Sikorsky S-60 Crane Makes First Flight

Sikorsky's S-60 flying crane helicopter made its first flight the day after the United Aircraft Division rolled out the Navy HSS-2 turbine helicopter (AW Mar. 30, p. 30). By last week it had amassed 9 hr. flight time. The rotor system and two Pratt & Whitney R2800 piston engines are the same as those of the company's S-56 permitting Sikorsky to compress its test program and to fly the S-60 to Ft. Bragg, N. C., late last week for an Army demonstration. The present ship uses a tail wheel landing gear layout. However, the company is testing on an S-56 bailed from the Navy a twin boom tail rotor system that would permit using a nose wheel instead, enabling free access for loading from the rear. The cockpit features a novel swiveling seat for the pilot, so that he can face forward in flight or backward in load handling (AW Oct. 13, p. 29). Various turbine engines are in consideration with GE T64s or P&W JT12s frequently mentioned.

detected by a space vehicle might be "as great as the intensity that occurs in here, or even more," and probably would last only a couple of hours. Implications of this for manned space flight will not be known until man knows the nature and the spectrum of the radiation, according to Jastrow.

• **If the solar origin theory** is correct, all effects would be expected to be greater at Venus, which is closer to the sun and is believed to have a magnetic field.

• **It is "very probable"** that auroras are caused by the outer-belt and "probable" that the Van Allen layer heats the upper atmosphere. "Surprising result" of a hotter atmosphere over Ft. Churchill in the Canadian Arctic than over Arizona has been discovered by rocket firings from both locations. Earth's magnetic field funnels the trapped particles into the auroral region, apparently causing the heating.

Lunar Probe

Pioneer III, an NASA-Army lunar probe fired last Dec. 6, measured out to 110,000 km. Its measurements indicated that the radiation belt actually was two belts, that it extended out from the center of the earth to 60,000 km., and that it had centers or peaks of intensity at 13,000 km. and 25,000 km.

Pioneer IV, launched on Mar. 3 following five days of intense solar and auroral activity, found little change in the intensity of the inner zone but intensity of the outer zone was greater than Pioneer III's readings by a factor of at least two—an interpretation favored by the Van Allen group—and possibly as high as 10, an interpretation favored by others at the conference. The highest scaler carried in the probe did not function properly, leading to the ambiguity.

The probe also found that the peak intensity shifted outward from the earth's center by 10,000 to 15,000 km. to a distance of about 35,000 km. It also found that at a point where Pioneer III's data had leveled off into a few counts per second per square centimeter, Pioneer IV's data was showing higher fluctuations by a factor of four to 10 over a period of some additional 10,000 to 15,000 km. This amounts to an extension of the "ragged" outer edge of the outermost layer from about 60,000 to about 70,000 km.

Peaks of intensity as judged by Pioneer III were 10,000 counts/sec./sq. cm. for the inner and 30,000 counts for the outer zone. Minimum count was about 3,000 at some 16,000 km. Counts for Pioneer IV's flight have not been revealed in numbers.

Implication is that the magnetic field of the earth disappears into the general noise level of interplanetary plasma and fields at about 60,000 to 80,000 km., or about 10 earth's radii, Jastrow said.

Outer belt has a strong "soft" radiation component which probably is electrons of about 50,000 volts, according to the Van Allen investigators. Soviet scientists also have said as a result of Mechta's flight that the outer belt definitely contains electrons in its soft, or less energetic component.

Van Allen's group also has found a penetrating component in the outer belt—either electrons of energy greater than 600,000 volts or protons with energies of the order of 100 million volts or greater—but they are in lesser numbers than the "soft" electrons.

Inner Belt

In the inner belt, the Van Allen group has definitely concluded that the hard, penetrating particles are protons. The softer particles, which outnumber the hard by 10,000 to one, may be either protons or electrons.

Gold believes that the evidence from Pioneer IV's flight "is very strongly suggestive, if not an absolute proof" that "a solar stream came and hit the earth," feeding fast particles into the trapped-particle area and leaving "a little bit of disturbance in the particle content and in the (magnetic) field, too, for a few days."

Blowlamp, Backfin Design Data Detailed

Budapest—New design details and performance specifications of the Ilyushin Il-140 (NATO code-named Blowlamp) and the Yakolev Yak-42 (Backfin), two of the Soviet Air Force's newest bombers, have been reported here.

The two 1,000-mph.-class bombers are now in active service, according to the Hungarian magazine Repules (Aviation), and are replacing the subsonic Ilyushin Il-28 which has been produced in quantity and has been in service for years with satellite air forces as well as Russian squadrons. Source of the information used in the Hungarian articles was described as recently released Russian data.

The Yak-42 Backfin medium bomber has a maximum gross weight of 128,000 lb. and a listed top speed of 985 mph. (Mach 1.28) at 49,000 ft. and cruise speed is 600 mph. at 42,600 ft. Its 6% thick wing has a crescent planform with a leading edge sweep of 60 deg. on the inner panels and 46 deg. on the outer.

Powerplants in the Backfin are two AM-3 axial flow turbojets (AW Mar. 30, p. 39) delivering approximately 18,000 lb. thrust each without augmentation and 22,400 lb. with afterburner. The engines are located side by side in the aft section of the fuselage, and the air intakes are well forward on the fuselage just behind the cockpit. They are shoulder type intakes just above the wing which is in a mid-wing location.

The Hungarian source describes the Backfin as the first Soviet aircraft with built-in installations for booster rockets. These rocket engine locations are on either side of the fuselage just behind the trailing edge of the wing.

Range of the Yak-42 is given as 1,860 to 2,500 mi. depending upon the load. Maximum bomb capacity is just over six tons, and the aircraft also can carry reconnaissance equipment.

Blowlamp Gross Weight

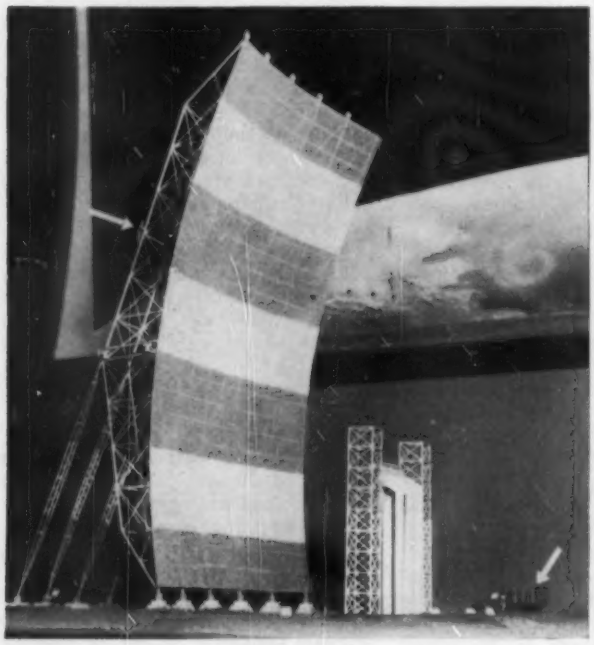
The Il-140 Blowlamp is about half the gross weight of the Backfin, weighing a maximum of 65,000 lb. It also is somewhat slower than the Backfin, with a top speed of 910 mph. at 39,500 ft. and a cruise speed of 700 mph. Maximum speed at 56,000 ft. is given as 725 mph.

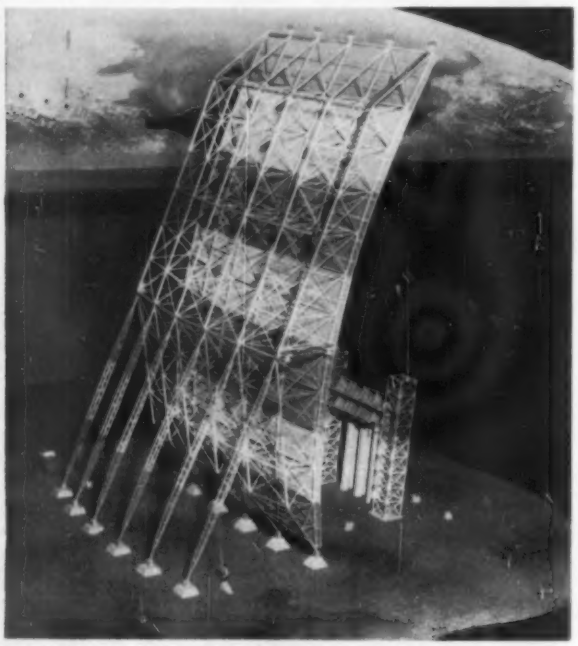
Blowlamp is apparently the first operational USSR aircraft with podded engines. Two M-209 engines without afterburners are carried, one under each wing. The wing is swept 50 deg. on the leading edge and mounted high on the fuselage with pods suspended from rather long pylons. Each engine delivers approximately 18,000 lb. thrust.

Bomb load of the Blowlamp is a maximum of 4,850 lb., and it may be carried internally or externally. Range of the two-place bomber on a combat mission is given as 745 mi. if it approaches the target at better than 40,000 ft. It could spend 35 min. in a high-altitude action above the target on this mission, according to Repules. On a low-level mission, the radius of action is 360 mi. with only 15 min. of combat.

Both the Backfin and the Blowlamp are equipped with tail turrets each carrying a 37 mm. radar-directed cannon. Additional armament aboard the Backfin includes six 105 mm. guided rockets for use against aircraft. The Blowlamp carries 18 guided rockets for attacking air or ground targets.

Physical characteristics of the Yak-42 medium bomber include a wing span of 67 ft.; length 100 ft.; height 26.5 ft.; wing area 900 sq. ft.; aspect ratio of four; dihedral of −3 deg.; empty weight of 55,600 lb.; fuel weight of 59,500 lb.; lubricant weight 440 lb.; maximum landing weight 74,000 lb.; landing speed 158 mph.; maximum rate of climb 24,000 fpm.; service ceiling 64,000 ft.; takeoff run of 6,100 ft. over 49 ft. ob-





BMEWS Antenna Displayed in Model Form

AN/FPS-17 radar antenna, prototype of units being developed for Ballistic Missile Early Warning System (BMEWS) installations in Alaska and Greenland, is shown in model form. Size of giant antenna, produced by D. S. Kennedy & Co., is illustrated by models of maintenance men and truck (arrows). The FPS-17 radar, produced by General Electric, is installed in Turkey to monitor Soviet ballistic missile test range, and in Laredo, Tex., for tracking ballistic missiles launched from Cape Canaveral, Fla.

stacle; landing run of 5,400 ft. without braking parachute.

The aircraft's full span leading edge slats apparently are large enough to provide an increase in wing area when they are extended. The plane also includes a glassed-in bombardier's compartment in the nose similar to that on the Tu-104 jet transports, with the bombing radar located on the underside of the fuselage behind this position, and one boundary layer fence on each semi-span.

Crew complement of the Yak-42 was not given exactly, but a total crew weight of 660 lb. was reported. On other Soviet aircraft, about 190 lb. is allowed per man for crew weight, but this figure apparently varies slightly with the design. It is probable that the Yak-42 carries three men at a design weight of 220 lb. per man rather than four men at 165 lb. each.

Additional physical characteristics of the Il-140 Blowlamp include: wing span 58.4 ft.; length 71.8 ft.; height 21 ft.; wing area 695 sq. ft.; aspect ratio of four; weight empty 34,000 lb.; fuel weight 25,600 lb.; lubricant weight 660 lb.; landing speed 146 mph.; landing run without parabrake of 4,750 ft.; landing run with parabrake of 2,630 ft.; take-off distance over 49 ft. obstacle of 3,670 ft.; ceiling of 59,800 ft.

Tandem Gear

The Blowlamp has a tandem landing gear that retracts into the fuselage. Two tires are on each wheel. The parabrake on the Blowlamp is 17 ft. in diameter.

The Backfin landing gear is tricycle type that retracts into the fuselage.

Blowlamp was first publicly displayed at Kubinka military airfield near Moscow in 1956 just after the Tushino air show (AW July 2, 1956, p. 26). Prototype Blowlamp was spotted during rehearsals for the air show but failed to appear in the air on the day of the Tushino show. It was displayed on the ground at Kubinka for Gen. Nathan Twining, then USAF chief of staff, and his staff.

Gen. Twining recently testified before the House Armed Services Committee that he had no information on what had happened to the Blowlamp program since he saw the prototype and said there was no evidence that it had been put into production or operational use.

Backfin was first spotted in the air around Moscow in June, 1957, during rehearsals for the annual Tushino show (AW Sept. 9, 1957, p. 30). The 1957 air show was canceled because of the internal political battle in the Communist hierarchy that resulted in the emergence of Nikita Khrushchev as the top leader. AVIATION WEEK published an artist's sketch of Backfin on (Jan. 20, 1958, p. 39).

New Soviet Submarine, Bomber Reported by Defense Officials

By Ford Eastman

Washington—New-type Soviet submarine, probably equipped with guided-missiles, and a Russian long-range bomber with capabilities "away beyond" existing types were reported by Defense Department officials in testimony before the House Defense Appropriations Subcommittee released last week.

Bare details of the bomber were reported to the subcommittee by Air Force Gen. Nathan F. Twining, chairman of the Joint Chiefs of Staff. Gen. Twining told the subcommittee that the Soviets are "building a new bomber now, which we have seen, away beyond the capability" of the turbojet Bison or turboprop Bear long-range bombers. The bomber, Gen. Twining said, "is a kind of big delta wing, with very long nose section and long engines. We do not know quite what it is yet, but it is an advanced heavy bomber."

As reported in an exclusive AVIATION WEEK story last Dec. 1 (p. 26), the Soviet aircraft described by Gen. Twining was reported as the prototype of a nuclear-powered plane designed to perform specific military missions.

Adm. Arleigh Burke, chief of naval operations, told the subcommittee that a new type submarine has been sighted and that the Soviets are begining to send it on sea trials. The submarine is not nuclear-powered, Adm. Burke said. He added, however, that, since the Soviets have reduced production of conventional submarines (AW March 9, p. 82), they probably are turning to nuclear-powered craft, guided missile submarines or a combination of the two, or possibly to a new design of conventional long-range vessel.

Defense Testimony

Highlights of other Defense Department testimony included:

• **Defense Secretary Neil H. McElroy** said he did not look upon the Minuteman solid-fueled intercontinental ballistic missile now in the development stage as an ultimate missile or as the only strategic weapon the U. S. will need. Solid fuel, he said, will not permit the lifting of as big a warhead as liquid fuel, and Minuteman will complement, rather than replace liquid fueled missiles and manned bombers. He said the Fiscal 1960 budget contains $260 million for Minuteman. Defense Department, he added, "applied" to the program in Fiscal 1959 $114 million above that originally programed without using the extra $90 million appropriated by Congress. This was accomplished by cuts and cancellations in other Air Force contracts.

• **Soviet Union is clearly ahead** of the U. S. in missiles of less than the 1,000-mi.-range, and the reason the U. S. may be behind Russia in intercontinental ballistic missile production within two to three years is that the U. S. also plans to rely upon other delivery systems, the Russians primarily upon ICBMs.

• **Gen. Twining** said the Joint Chiefs have made 18 airlift studies since appropriations hearings last year and four out of five members of the Joint Chiefs were in agreement that airlift capability was adequate as a basis for planning to meet limited and general war situations. Dissenter apparently was Army Gen. Maxwell Taylor.

• **The U. S., McElroy** said, has decided upon a combination of dispersal and hardening of missile sites as protection against destruction during attack. "This way," he said, "if you have 10 launching sites and he (the enemy) puts a salvo of 10 missiles against what was your old concentrated site, they may all impact on one of the dispersed sites so you have nine left. That way, he has to have a much greater initial attack capability in order to knock us out."

Air Force

Highlights of Air Force testimony included:

• **Aircraft procurement funds**—Maj. Gen. James Ferguson, USAF director of requirements, said the Air Force is requesting $4,409.1 million in new obligational authority for Fiscal 1960 which will permit it to carry out an aircraft procurement program totaling $4,813.9 million as compared with

Republic Layoff

New York—Republic Aviation Corp. will lay off 2,300 employes as a result of USAF's decision to change its order for the F-105E two-seat all-weather fighter bomber to an equal number of F-105D single-seat all-weather fighter bombers.

Eight F-105Es currently in production will be converted to F-105Ds. Production of the F-105B single-seat day fighter bomber ends this year and will be succeeded by the F-105D.

Layoffs will be necessary since several months are required to order and receive parts and to rearrange production schedules for the changed program, according to Mundy I. Peale, Republic president. Republic currently employs 17,000 persons.

$5,191 million for Fiscal 1959. Procurement program calls for a total of 703 aircraft, Ferguson said. The program also provides for nearly 300 jet training aircraft, 10 jet cargo transports and 18 C-130Bs, plus 14 additional in Fiscal 1959.

• **Nuclear-powered aircraft need**—Gen. Ferguson said the Air Force needs a nuclear-propelled plane to achieve the endurance needed to give more flexibility in the bomber force and to increase the efficiency of the airborne alert operations.

• **Missile procurement**—Gen. Ferguson told the subcommittee that new obligational authority requests for Fiscal 1960 in this category totals $2,601.2 million and will finance a program totaling $2,763.1 million as compared with a Fiscal 1959 program of $3,060.8 million. About 55% of the funding provided will be for production and development of the Atlas and Titan ICBMs and development and testing of the Minuteman. Development, test and evaluation support effort amounts to $885.2 million.

• **SAGE progress**—Five facilities of the SAGE early-warning system are now in operation and five more will become operational by end of 1959.

• **Soviet lunar probe**—Air Force Secretary James H. Douglas, told the subcommittee that the Russians apparently had two and possibly three failures before successfully launching a lunar probe earlier this year (AW Jan. 12, p. 26). He said they also have had failures in satellite launchings.

• **Manned-bomber advantages** — Gen. Thomas D. White, Air Force chief of staff, said one advantage of the bomber over the ICBM is that it can carry multiple nuclear weapons. It also can carry a much bigger yield and variety and it can be redeployed, Gen. White pointed out. In addition, he said, it has a greater potential for use in limited war. Because of the low circular probable error of the modern jet bomber and the high yield of the weapons which can be carried, only one independently aimed multimegaton bomb is required to assure a 90% probability of destroying a point target, Gen. White said.

Navy testimony included:

• **Polaris funds for Fiscal 1960**—Navy Secretary Thomas S. Gates, Jr., testified that the Defense Department is requesting $611,568,000 in new obligational authority for the solid-fueled submarine-launched Polaris ballistic missile. This amount, he said, will provide for completion of funding of one new construction tender; advance procurement items for three fleet ballistic missile submarines to be included in the Fiscal 1961 shipbuilding program; continuation of missile development; research on the command communications system; operation of test ships; operation and construction of support facilities, and training of personnel.

• **Conventional powered aircraft carrier**—Carrier proposed in the Fiscal 1960 program, Gates said, will be an improved version of the Forrestal class. It will have two twin Terrier missile-launching systems, an automatic all-weather landing system and be capable of operating aircraft weighing up to 80,000 lb.

• **Aircraft size**—Burke told the subcommittee that the Navy has reached what it believes to be the limit in aircraft size and landing approach speeds for carrier operations.

• **Pacific Missile Range**—Fiscal 1960 budget submitted by Navy contains $126.188 million in new obligational authority for development of the range, Gates said. Funds will be used to extend the capability of the sea testing range from 250 to 500 naut. mi., provide increased reliability in the impact location system of the intermediate range ballistic missile training range, provide additional facilities, complete the IRBM training range by installation of facilities at Midway and Eniwetok, convert and provide partial instrumentation for a merchant hull to serve as range ship to extend range facilities into ocean area for satellite recovery and to give increased flexibility to the range.

• **Reconnaissance satellites** employing optics, infrared and radar—Adm. Burke said such weapons will not present too much of a problem for aircraft carriers. The satellite, he told the subcommittee, would have to be at a very high altitude to remain in orbit, and will not be able to determine the position of a ship with accuracy.

• **Anti-submarine warfare**—Gates said the Navy is working on fast hydrofoil boats with a 200-mi. radius. It also is working on high-speed dunking sonars with improved search speed and development of new sonar ships.

Army testimony included:

• **Nike Zeus anti-ICBM funding**—Army Secretary Wilber Brucker said he had recommended about $1 billion for Fiscal 1960 to expedite development and initiate production of long lead time items in the Nike Zeus system. William Holaday, Defense Department director of guided missiles, approved $626 million, but the final budget figure was cut down to $300 million for research and development only.

• **Continental air defense**—Gen. Maxwell D. Taylor, Army chief of staff, said at the end of Fiscal 1959 there will be 62 surface-to-air missile battalions on site and operational. By the end of Fiscal 1960, it will be increased by one battalion to 63. In addition there will be 10 battalions deployed at overseas bases.

• **Surface-to-air missile procurement**—Procurement in Fiscal 1960 will be lower than either of the two previous years, Gen. Taylor said, because of the elimination of the Redstone program and the lower level of procurement for ground handling equipment. However, funds are included in Fiscal 1960 to improve Nike Hercules performance against jamming by radar and other electronic countermeasures.

• **Cancellation of Dart anti-tank program**—Secretary Brucker said the Dart guided anti-tank program was terminated last September in the interests of efficiency and economy.

• **Improvement program for Honest John system**—Brucker said the project will be completed within the next two years. Improvements will provide higher mobility, increased accuracy and longer range in comparison with the currently operational Honest John surface-to-surface missile.

Backlog Increases At General Dynamics

General Dynamics Corp. reported a backlog of over $2 billion at the end of 1958, a year in which the corporation recorded sales of $1,511,456,261 and earnings of $36,729,113.

These totals were second only to 1957's record sales of $1,562,538,900 and earnings of $44,278,763. The 1958 earnings were equivalent to $3.71 a share, compared with $4.80 a share the previous year.

Besides the backlog listed, the corporation also had contracts under negotiation at year end totaling $645 million. The 1958 total of $2,095 million compared with $1,750 million a year earlier.

Other financial reports:

• **Bell Aircraft Corp.** sales in 1958 dropped to $182,887,229, compared with $202,252,534 the year before, but earnings rose from $4,346,429 or $1.62 a share in 1957 to $4,758,700 or $1.77 a share last year. Commercial sales accounted for 35% of the corporation's net income.

• **Kaman Aircraft Corp.** sales rose $6 million to total $21,422,642 in 1958. Earnings also increased from $467,732 in 1957 to $513,012 in 1958.

• **Fairchild Engine & Airplane Corp.** reported a net loss of $17,435,761 for 1958 after a $5,840,000 tax credit primarily due to write-downs on its F-27 turbine transport program. Backlog declined from $170 million to $130 million. Sales declined from $158,621,612 in 1957 to $148,016,589 in 1958. The company had earned $503,331 in 1957.

Argus Potential as Weapon Described

By Ford Eastman

Washington—Total area blackout of radar and radio communications could be produced from high-altitude nuclear blasts similar to the Project Argus tests of last August and September (AW Mar. 23, p. 35; Mar. 30, p. 26) in order to disrupt the reaction capability of a nation under attack, according to Roy W. Johnson, director of Defense Department's Advanced Research Projects Agency.

Testifying before the Senate Subcommittee on Governmental Organization for Space Activities, Johnson said the Project Argus tests indicated that strategically placed high-altitude nuclear blasts could result in total blackouts of radio and radar in certain areas. As an example, he said the explosion of a nuclear weapon in outer space in the Indian Ocean area probably would result in a total blackout for various periods of time of all radar and radio communications in the Moscow, Stalingrad and Leningrad areas.

Release of a nuclear weapon by the Soviet Union in a strategic location also could similarly blackout radar and radio communications here, Johnson said.

Johnson said that the U.S. has not yet correlated all the information gained from the Argus tests and that some of the initial conclusions may have to be altered. He also told the subcommittee that:

- **Studies are under way** on a project to place a 1,000-ton manned platform into space using the detonation of small atomic bombs for lift. Studies will cost about $1 million.
- **It would be possible to conscript** scientists and engineers for duty on military space projects much in the same manner as professional men are now drafted for duty in the armed forces but that he would be opposed to any such action.
- **He does not feel that the military-civilian** liaison committee as provided in the National Space Act of 1958 is necessary because persons concerned with military and civilian programs at a working level will, of necessity, cooperate.
- **It would be impossible** to have a single space program. He said that after initial military and civilian space exploration requirements are determined space requirements will be entirely different, including the type of hardware and boosters needed for varying missions.
- **Improvements in the satellite** detection fence now under construction in the southern U.S. will make it impossible for any country to orbit a satellite at least one square meter in size at altitudes of up to 1,000-mi. without the U.S. knowing it. Other improvements within a year should increase the ceiling to 3,000 mi.
- **Almost half of ARPA's** total personnel strength of 80 is engaged in research for a defense against intercontinental ballistic missiles, including the death ray concept.
- **ARPA may place a contract** with the Rand Corp. to detail where and how far the U.S. can go into space during the next 20 years.
- **ARPA has saved** the nation "hundreds of millions" of dollars by preventing duplication of space projects but that it must remain a coordinating agency and not become a fourth operating agency.
- **In the event of a total** Strategic Air Command alert, there some present, and vital communications would be disrupted by sun spot interference. This could be corrected by a military communications satellites.

Johnson will continue to recommend that the Army Ballistic Missile Agency remain within the Defense Department rather than be transferred to the National Aeronautics and Space Administration as proposed by NASA.

T. Keith Glennan, NASA administrator, told the subcommittee that:

- **Top-level Space Council,** established by law as the nation's top policy group on space matters, holds no regular meetings. Four meetings of about two hours each have been held over the past five months—Sept. 24, Oct. 9, Dec. 3, and Mar. 2. All of the meetings were presided over by the President.
- **Executive secretary to manage** the functions of the Council has not yet been appointed. The Space Act authorized a secretary, to be appointed by the President and confirmed by the Senate, at a salary of $20,000 a year. An "acting secretary," Franklin Philips, is now with NASA at $16,500 a year.

Glennan repeatedly declined to give the subcommittee, headed by Sen. Stuart Symington (D.-Mo.), any information on the deliberations of the Council, on the grounds that it is a confidential advisor to the President.

Glennan's report on the steps in the development last year of the first military-civilian space program showed that the Council did not figure porminently.

First, there were meetings between representatives of NASA and the Department of Defense on the division of effort. Two meetings were held, both presided over by Dr. James T. Killian, the President's scientific advisor. Participants were Deputy Secretary of Defense Donald Quarles, Dr. Herbert York, Defense Department director of research and engineering; Lawrence Gise and David Young, of the Advanced Research Projects Agency; Glennan; Dr. Hugh Dryden, NASA deputy administrator, and Abe Silverstien, NASA director of space flight development. The programs were then "costed" by Defense and NASA and presented to the Budget Bureau, which eliminated the request for construction facilities.

The national space program reaches the President via the Budget Bureau, Glennan said, and the President can then ask advice of National Aeronautics and Space Council if he wants.

Glennan said that Dr. Killian also serves as chairman of the working level civilian-military committee to resolve duplications between ARPA and NASA.

Sen. Symington protested that there is no over-all national space program, nor even plans to develop one. Glennan replied, however, that, although there is no "one ball of wax," all the individual projects "add together into a national program."

Titan Guidance Switch

Washington—Air Force will switch back to inertial guidance for its Martin Titan intercontinental ballistic missile and expects to name its choice of contractor within two weeks. Four companies are in the final competition: AC Spark Plug, Kearfott, Minneapolis-Honeywell and Northrop's Nortronics Division.

American Bosch Arma's inertial system, originally developed for the Titan, was reassigned to the Convair Atlas last summer when USAF decided that mass salvo capability and jamming invulnerability of inertial guidance outweighed the somewhat better accuracy of the General Electric-Burroughs Atlas radio command guidance system. At the same time, radio command guidance system being developed for Titan by Bell Telephone Laboratories and Remington Rand as a backstop to Arma's inertial system was assigned to Titan. Now Air Force plans to go all-inertial in all its ICBMs, but is reluctant to put all of its eggs in the Arma basket. (For details on growing inertial guidance market, see p. 52.)

Space Technology

Detailed Sun Pictures Recorded By ONR Aerobee-Hi Rocket

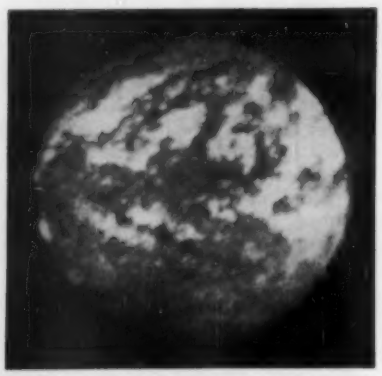
Washington—First highly detailed photographs of the entire sun, using ultraviolet radiation originating in the outer portions of the solar atmosphere were obtained on March 13 from an Aerobee-Hi rocket at 123 mi. altitude.

Specially developed camera and film which were sensitive only to light of the Lyman-alpha line of hydrogen in the ultraviolet region of the electromagnetic spectrum produced photographs which indicate that such radiation is emitted from spots and patches over the solar surface.

Tests were conducted by Office of Naval Research scientists as part of the U.S. participation in the International Geophysical Year program, under sponsorship of National Academy of Sciences. Rocket carrying the special photo equipment was launched from White Sands Missile Range.

Ultraviolet and X-ray radiation from the sun, impinging upon the earth's atmosphere, produces the ionspheric layers in the upper atmosphere which reflect radio waves in the high frequency (HF) band and at lower frequencies used for long-distance communications. Sun spots and other extreme solar disturbances are known to produce disruptions in long-range radio communications and changes in propagation. Scientists also suspect that such solar radiation may play an important role in determining terrestrial weather conditions.

Because this radiation is attentuated by the earth's atmosphere, it has been impossible previously to make an ultraviolet photograph of the sun from the earth. This had made it impossible to correlate the intensity and location of such solar radiation with the same phenomena as viewed in the visible light spectrum through telescopes.



FIRST ultraviolet photograph of the sun's atmosphere was taken from an Aerobee-Hi weather research rocket fired by Naval Research Laboratory scientists to an altitude of 123 mi. from White Sands, N. M., on March 13. Hot clouds of hydrogen gas (white areas) are 4,000-6,000 mi. above sun.

During the recent experiment, simultaneous photographs of the sun were made on the earth using solar radiation emitted at two other wavelengths, the red line of hydrogen and the violet-K line of ionized calcium. Photographs were made at the Mount Wilson Observatory in California, the McMath-Hulbert Observatory in Michigan, the Air Force Observatory at Sacramento Peak in New Mexico and at Naval Research Laboratory in Washington.

The rocket-made Lyman-alpha photographs show the solar weather pattern at the highest level in the solar atmosphere yet studied over the entire solar surface, with the calcium-K line mapping the atmosphere farther down into the interior and the red line of hydrogen photos showing the pattern still lower in the solar atmosphere.

In combination, the three will give a three-dimensional picture of the processes taking place in the sun's atmosphere, NRL scientists say. When viewed by the extreme ultraviolet light of hydrogen, the sun appears extremely stormy. The same bright disturbed areas also can be seen in the photographs made by ground observatories, but are smaller and less conspicuous. This agrees with present theories of ascending columns of turbulent gas spreading, combining and merging as they stream out of the sun.

Traces of these gases are believed to reach the earth. During periods of great solar activity, they produce aurorae and magnetic storms and seriously disrupt long-range radio communications.

Through the use of rocket astronomy, NRL scientists hope to be able to obtain daily solar weather reports and use them to predict their reactions on the earth's weather and radio communications.

The camera used to make the ultraviolet solar photographs was developed by NRL over the last four years. Because ultraviolet radiation is absorbed by any material, a conventional lens could not be used. The camera had to be constructed using diffraction gratings, which function as optical mirrors and filters to pass only ultraviolet Lymanalpha radiation.

Special film also had to be developed because the gelatine binder used in ordinary emulsion also absorbs ultraviolet radiation before it reaches the sensitive silver-halide grains. Special film used contained almost no gelatine, but this required extreme care in handling to preserve the image.

The camera was aimed at the sun and stabilized against rocket rolling, pitching and yawing motions by means of a photocell-directed stabilization system which was built at the University of Colorado.

Demand Is Increasing For Avionic Engineers

New York—Demand for electronic engineers may be headed for new peaks, an AVIATION WEEK spot check at the recent national convention of the Institute of Radio Engineers has revealed.

Recruiters for nine companies, representing perhaps 20% of those actively recruiting here, told AVIATION WEEK that they seek to hire a total of nearly 6,000 engineers during the remainder of this year.

Although most recruiters reported fewer job applicants than at last year's IRE convention, nearly all said that the quality and experience level this year is considerably higher. Possible explanation is that many of last year's applicants were men hit by industry cutbacks and layoffs, with the better men sitting tight in the face of uncertainty.

Salary levels are up slightly, ranging from 5 to 10% over last year, most recruiters agree, except for much-sought specialists and experienced men. Engineers with systems engineering, digital computer and telemetry experience are much in demand, but companies generally are seeking talent throughout the electronics field. Junior engineers with five years or less experience are being sought by companies such as Aeronutronic Systems, Lockheed and Space Technology Laboratories to round out their present complement of Ph.D.s.

In addition to recruiting by individual companies, several employment agencies were active at the IRE convention. One placed memo pads in all convention hotel phone booths, reminding applicants to call for job opportunities.

Results of the four days of recruiting won't be known for several weeks.

Recruiters are mixed in their opinions on whether the situation will get more frantic in the coming months. Those who expect demand for engineers to grow point to the increased percentage of research and development required for space technology and the growing numbers of companies seeking to get into that field.

U. S. Army's 40th Artillery Group, first unit supplied with Redstone intermediate range ballistic missile to serve abroad, readies the IRBM for placement at Eckweiler, Germany. Newly-developed A- and H-frame technique, right, raises the Redstone from its transporter.

First Overseas Redstone Unit Trains in Germany

Redstone base is checked (left) as it nears firing position. At right, lines for alcohol-liquid oxygen fuel are attached. The Redstone unit trained at Cape Canaveral, Fla., (AW June 2, p. 49) for a year before its transfer to Germany.

FLOATING while in a weightless condition are Maj. Edward L. Brown, left, and Lt. Melvin Gardner. Lt. Gardner propels himself about the cabin using a compressed air reaction gun.

COMPRESSED air reaction system (left) consists of six bailout bottles strapped to subject's back. At right, test subject walks upside down, on C-133B ceiling, using magnetic shoes.

Weightless Experiments Detailed

Washington—Man can become oriented and feel right side up while standing on his head when he is weightless according to latest findings of Air Force scientists at Wright Air Development Center. It may be impractical, however, for man to use a reaction unit or flying belt type of device for individual propulsion in space, the scientists say.

Tests have shown that under weightless conditions a man walking on the ceiling of a test aircraft using magnetic shoes instinctively feels that everyone else in the aircraft is upside down. This phenomenon has been verified with several different persons during flights in a modified Convair C-131B. Tests were conducted by the Crew Stations Research Section at Wright's Aero Medical Laboratory's Engineering Psychology Branch (AW Dec. 22, p. 52).

These flights along a Keplerian trajectory leave the aircraft and those in it in a weightless condition for 12 to 15 sec. under normal conditions. Tests thus far have shown that magnetic shoes with 5 lb. attraction are not satisfactory for walking on a ceiling but that a 22 lb. attraction per foot is adequate.

A low thrust individual propulsion unit also has been constructed and tested which showed that man will have a major problem in controlling his body attitude and movements as he is propelled from one point to another. Problem is so marked that predictions now are that man will have to move about space in some type of scooter or seat on which the man's center of gravity stays constantly in line with the center of thrust of his propulsion system. The system which has been tested at Wright Field consists of six bail-out bottles strapped together in a back pack with all of the bottles manifolded to a hose with a nozzle on the end. The man holds the nozzle in his hand to control direction of the thrust.

One of the most extensive portions of the studies being carried on by the Crew Stations Research Section under Maj. Edward L. Brown concerns the flow of liquids under weightless conditions where pressure feed systems do not guarantee the movements of liquids. Tests have shown that liquids tend to move in great globules during zero gravity and bubbles move randomly.

NATO Hawk Delivery May Begin in 1961

Paris—Initial production program for the building of the U. S. designed air defense missile, the Army-Raytheon Hawk, by five NATO nations of western Europe reportedly will involve 22 battalions with initial deliveries slated to begin by June, 1961.

Final approval of the program by NATO council is expected sometime in April. This will mark the first success of U. S. policy established at the 1957 NATO summit conference. At that session, President Eisenhower promised NATO nations the U. S. would help establish in Europe large-scale production of advanced type weapons.

In addition to the Hawk program, negotiations for European construction of the Sidewinder air-to-air missile are also nearing agreement.

Initially, the Hawk program was aimed at 28 battalions. But France, because of budgetary considerations, has now reduced its participation by two-thirds. While final details still remain to be worked out, the program currently is divided as follows:

West Germany, nine battalions; Italy, four battalions; France, three battalions; Belgium, three battalions and Holland, three battalions.

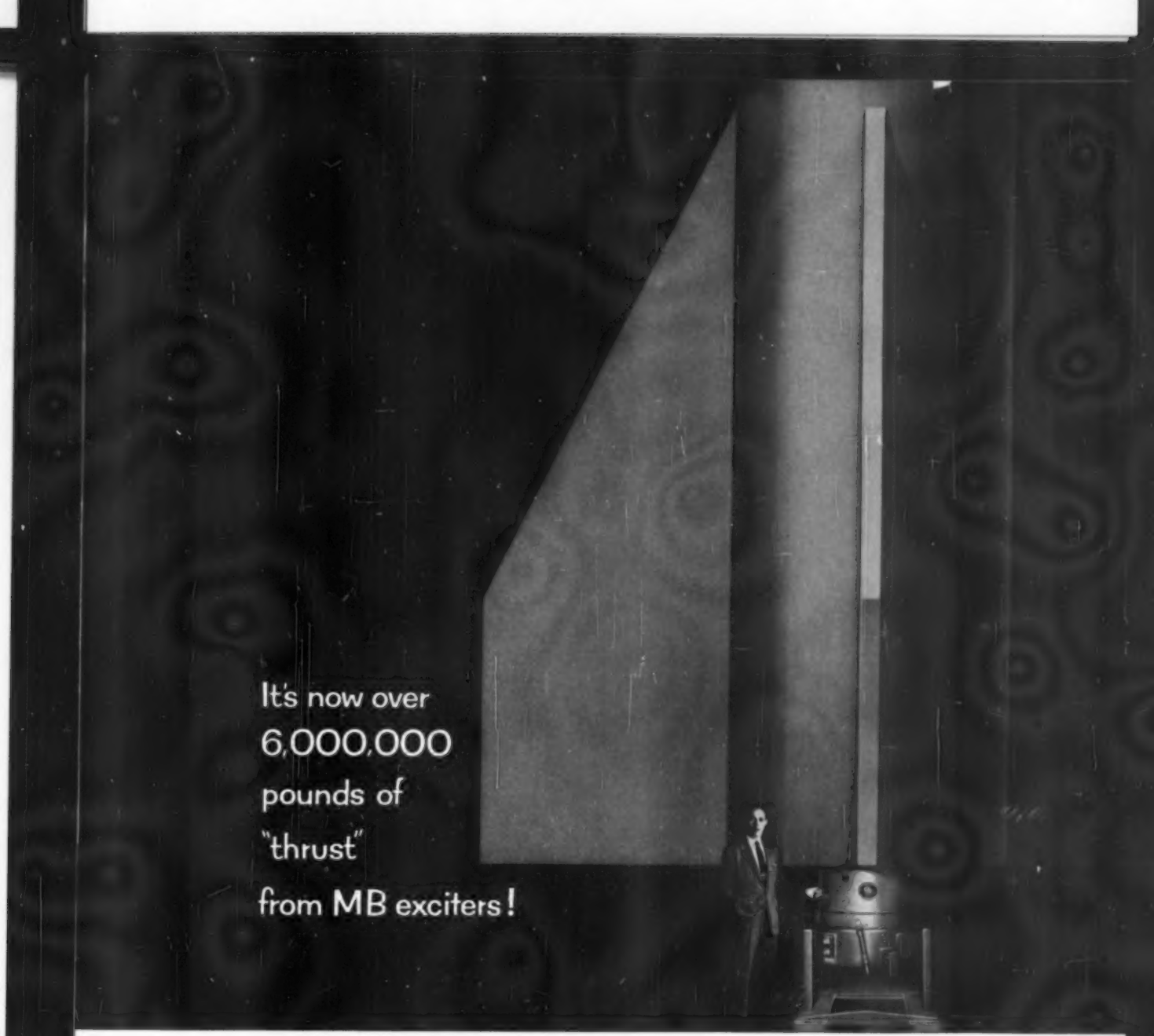
Cost of the program for the five nations involved is estimated at $440 million. U. S. financial assistance in various forms for the initial 22 battalion program which is expected to run until 1964, will be about $40 million over this period.

While the initial Hawk program has been fixed at 22 battalions, this figure may be increased by six or eight battalions if the U. S. later decides to place off-shore orders for the Hawk in western Europe. The possibility also exists that European nations involved in the program may in the future increase their participation. Some observers expect that as many as 50 Hawk battalions may be supplied by the European program.

European companies involved in the Hawk program are **Ateliers de Construction Electrique de Charleroi, Belgium; Telefunken, Germany; Finmeccanica, Italy; Philips, Holland,** and Thomson-Houston, France. Despite reduced French participation, Thomson-Houston will remain as technical coordinator of the group.

Additional European companies will come into the program as subcontractors. It is expected France and Germany will pool their efforts, as will Belgium and Holland.

Over-all management company for the group, named Societe European de Teleguidage, has been set up as an international company under French law.



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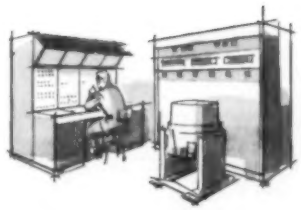

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Pluto Design Proposals Evaluated by ARDC

Washington—Evaluation of three major studies outlining possible future uses of nuclear-powered ramjet engines is now being conducted by ARDC.

Studies were performed during the last three years by Chance Vought, San Diego Division of Convair and North American Aviation's Missile Division. Completion date for the studies was Feb. 28.

Such a vehicle, in its simplest form, would be little more than a flying ramjet with the nuclear reactor replacing the conventional combustion chamber (AW Mar. 2, p. 38). The payload would be carried in the cylindrical centerbody of the diffuser section of the ramjet. Present aerodynamic information indicates that such a cylindrical vehicle would not need wings to cruise at low supersonic speeds.

Theodore Merkle, technical director of the Atomic Energy Commission's Project Pluto which has been performing research on nuclear ramjets, has testified that these powerplants are feasible with present knowledge and that they may be constructed with presently used materials. Merkle says, "It is just a matter of do you want it or not."

Present plans call for ARDC to give the Air Staff an early briefing on the potentialities of nuclear ramjet vehicles as outlined by the companies which have submitted the design proposals. Air Force Weapons Board composed of general officers and headed by Maj. Gen. James Ferguson, USAF director of requirements, also will review the proposals and ARDC's presentation.

Controllable Stage Employed in Mechta

Moscow—Use of a controllable final stage for the recent Soviet Mechta solar satellite (AW Jan. 12, p. 26) and the ability to introduce minor trajectory changes of the payload after separation from the final stage appears to explain the apparent precision of the probe.

A recent article in Pravda reports that "control of orbit of space rocket" out to distances of 300,000 mi. was accomplished by means of a "special radio electronic system operating at 183.6 mc." Separate transmitters operating at approximately 20 mc. were used to telemeter back scientific data. Article does not indicate how trajectory corrections were produced in payload.

Automatic radar stations were used to track Mechta during the early portion of its flight, but subsequent trajectory determinations were made by an interconnected network of "radio-electronic" stations throughout the USSR.

This suggests that the Russians are using a radio-command guidance system similar to one developed in the U.S. by General Electric/Burroughs employing Doppler techniques for guidance of the Atlas intercontinental ballistic missile.

Mechta's speed at burnout was automatically controlled, Pravda says, in order to achieve a velocity which would bring the probe into the vicinity of the moon at a time when it could be viewed by "radio means located in the territory of the Soviet Union and in other countries of Europe, as well as in Africa and in the larger part of Asia."

Servo Corp. Designs New Omnirange Unit

New York—New type of omnirange designated Doppler-VOR which provides considerably improved accuracy over conventional VORs in difficult siting areas where there are nearby natural or man-made obstacles will be marketed by Servo Corp. of America.

New Doppler-VOR is fully compatible with existing airborne receivers without modification or special procedures (AW Oct. 13, p. 43). Evaluation tests conducted by Federal Aviation Agency at an extremely unfavorable mountainous, wooded site in Charleston, S. C., showed over-all station error of only 0.9 deg., comparable to that obtainable from conventional VOR at a good station site. New type VOR makes it possible to install the station at an optimum location for the air route structure without costly clearing operations.

Lockheed Acquires Seattle Shipyard

Los Angeles—Lockheed Aircraft Corp. has purchased controlling interest in Puget Sound Bridge and Dredging Co., Seattle. Acquisition will focus emphasis on nuclear-powered ships and ground support facilities for missiles and space vehicles. Robert E. Gross, Lockheed board chairman, said the shipbuilding yards and shops in Seattle's harbor will give Lockheed a participation in the promising potential of ship construction, modernization and repair for the armed services, U. S. Merchant Marine and other operators.

"With our planned investment in new additional facilities, we believe we may become eligible for a part in building atomic submarines, which apparently are destined to become the capital ships of the future," Gross said.

Details of the transaction were not revealed. Except for the planned expansion, no change is contemplated for Puget Sound's management, personnel or policies.

News Digest

Grumman Aircraft Engineering Corp. has received a $101.7 million contract for development and production of the Navy A2F-1 turbojet attack aircraft. Contract is the first to be let by Navy on a cost-plus-incentive-fee system which correspondingly increases or decreases Grumman's profit on a basis of the A2F-1's actual over-all performance, as well as on Grumman's control of costs.

North American X-15 high-altitude research vehicle made its second successful captive flight last week beneath the wing of its B-52 mother ship. Flight, lasting 1 hr., 45 min. was made from Edwards AFB, Calif. Indications were that the flight was routine, with no complications noted.

West German government's order for 130 Sud Alouette Aviation turbine-powered helicopters brings the company's Alouette order backlog to 469.

Seaboard and Western Airlines agreement to acquire a quarter share in Aerlinte, the transatlantic Irish airline, is off. A government announcement gave no reason for the decision.

Russia's Alexander Nesmeyanov told the USSR Academy of Sciences there is no doubt Soviet exploration of the moon and nearest planets will be achieved by 1965.

Italy and the U.S. have completed formal agreements for the stationing of Jupiter intermediate range ballistic missiles in northern Italy. Missiles will be manned by Italians, with the nuclear warheads in the custody of U.S. personnel. Under the agreement, it will require an order from both governments before the warheads can be used. Training of the operational troops in Italy will be conducted by Strategic Air Command's 864th Strategic Missile Squadron.

Decision on a contractor for operating and maintaining Pt. Arguello portion of the Pacific Missile Range is scheduled to be made by Navy by the middle of this month. Function of the contractor will be similar to that of Pan American World Airways at the Air Force Missile Test Center, Cape Canaveral, Fla. Bidders include Chrysler, Pan American, Bendix, Radio Corp. of America, Philco, International Telephone and Telegraph, Lockheed Aircraft Service, Aeroject-General and Holmes & Narver, a West Coast engineering firm.

Allegheny Drafts Commuter Service Plan

Airline will employ turboprop Convair conversions to provide high-frequency, no-reservation runs.

By L. L. Doty

Detroit—Introduction of a fleet of turboprop Convair 340 or 440 transports coupled with a high-frequency, no-reservation, low-fare commuter service between key cities will mark Allegheny Airlines' entry into jet competition.

Decision as to whether the airline will power its Convairs with the Allison 501 or Napier Eland turboprop engines has not yet been made. However, company reaction to a demonstration flight conducted jointly last week by Napier and Canadair may make the Canadair 540 the leading contender to win a bid from the carrier. Flight marked the beginning of a three-month sales tour within the U.S. by Canadair (AW Mar. 30, p. 44).

Canadair 540 is the designation given the Napier Eland turboprop Convair 440 being manufactured by Canadair Ltd. with jigs and tooling purchased from Convair. The manufacturer also is offering potential customers the Convair 540—its designation for 340s and 440s built by Convair and converted to Eland power.

Supporting the turboprop fleet, which Allegheny will introduce next year, is a proposed low-cost, mass transportation, short-haul philosophy that pares ground handling costs to a minimum yet provides fast, frequent commuter flights between major cities.

F-27 Prospects

Ultimate goal for Allegheny is an all-turboprop fleet, Leslie O. Barnes, the company's president, told AVIATION WEEK during the demonstration flight from Washington to Detroit. At present, the Fairchild F-27 appears to be the leading contender to augment the Convair fleet.

No decision for the secondary turboprop fleet will be made in the near future, however, since the company will continue to operate its 11 Martin 202s and 12 Douglas DC-3s until it is in a position to expand its re-equipment program. During the final phaseout of piston-engine equipment, the Martin will replace the DC-3 and the F-27 will replace the Martin.

Choice of the F-27 to augment the Convair fleet rests on an anticipated increase in the airplane's gross takeoff weight as a means of cutting the number of refueling stops that are estimated by the company to be required on present routes under the plane's current operating characteristics.

The Convair, Martin and DC-3 fleet will adequately serve Barnes' new concept of high-speed commuter service. He said the airline has applications for such nonstop commuter service between Cleveland and Detroit and between Pittsburgh and Buffalo, Louisville, Baltimore, Washington, Syracuse.

Barnes envisions as many as 21 daily commuter flights between Detroit and Cleveland. Two fares would apply under the proposed plan: regular $8.80 fare for passengers who want reservations and a $6 fare for passengers without reservations. In-flight service and seating would be the same for both classes of travelers. The Allegheny president explained that reduced costs resulting from the no-reservation and simplified ticketing procedures would justify the lower fare. He estimated that each station would require a working passenger service staff of no more than six people. Passengers without reservations will purchase their tickets at the loading gate, where a cash register with an automatic ticketer would be located. The passengers would be accommodated according to the numbers on their tickets. "We borrowed this idea from the butcher shop," he said.

Barnes, who believes that passengers may actually seek to escape the inconveniences of making reservations, says: "Reconfirmation, early ticket pickup, cancellation of space because of a change in plans, standing in line at ticket counters, waiting for checked baggage are burdens many passengers want to avoid."

Need for New Concept

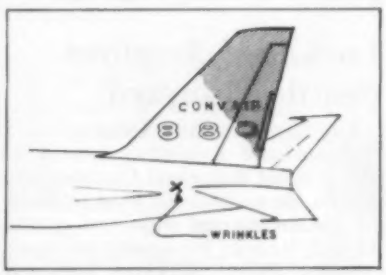
Barnes said little ingenuity or imagination has been applied to the development of markets under 300 mi. because trunklines have concentrated on long-haul markets and local service carriers have been restricted in operating the shorter routes. He noted that a completely new concept of passenger handling tied in with low fares would generate the mass market local-service carriers' need to maintain break-even load factors.

In this connection, Allegheny did not raise its passenger tariff to the full degree authorized by the CAB's fare increase in February, 1958, because, according to the company's annual report, "there is a real danger that . . . the short-haul airlines can price themselves out of profitable markets."

In choosing turboprop equipment, Barnes and his executive staff measured all existing or planned turboprop equipment against operating costs of the Martin 202 under all known operating conditions on the carrier's routes, including weather cancellations and air traffic delays. The Convair turboprop took first place in these studies primarily because of costs, capacity and range.

Barnes emphasized the importance of range in local service operations. He said that all refueling must be confined to major stops whenever possible because of the relatively high costs of refueling at points where local fuel taxes are high and lack of bulk storage facilities increases the cost per gallon.

In addition, he said, frequent refuel-



Convair 880 Damage

Drawing shows the approximate amount of vertical stabilizer and rudder lost (shaded area) by the No. 1 Convair 880 jet transport during a high speed dive, which was part of a flutter test investigation on its 26th flight. Convair test pilot Don Germeraad landed the disabled aircraft on the dry lake bed at Edwards AFB, Calif., using differential engine power for directional control. Examination on the ground showed that severe stresses had been imposed by the failure, evidenced by wrinkles in the fuselage skin just forward of the horizontal stabilizer. The aircraft was flying at 26,000 ft. about 20 mi. south of Catalina Island, off the California coast.

ing prevents the use of a three-minute stop at each station, a factor that prevents passengers from complaining too harshly against flights which are not nonstop.

During the demonstration flight between Washington and Detroit and return, the Canadair operated 1,125 mi., made 11 stops and one courtesy flight and refueled once—at Detroit.

The flight held 20 min. over Bradford, Pa., awaiting weather clearance. On a segment between Wilmington and Erie, the plane was held in a traffic pattern near Wilmington for approximately 25 min. waiting for clearance through north-south airways.

Control Needs

Both delays emphasized the urgent need local service carriers have for improved air traffic control and navigational facilities. Both trunkline and local service operators experience similar delays because of air traffic. However, a 20 min. delay on a transcontinental run normally can be at least partially absorbed during the course of the flight, while a 20 min. delay on a 30-min. flight virtually negates the type of commuter service Barnes is striving to introduce.

Range of the Canadair 540 with a 48 seat configuration has been set by the manufacturers at 1,100 mi. including six stops and allowing for a 100 mi. or 45 min. fuel reserve. Range of the airplane with 58 seats is 750 mi.

Direct operating cost on stage lengths of 300 mi. is one and one-half cents per seat mile. Total direct operating cost is $205.70 per hour including $30 per hour for engine labor and materials and $24.10 per hour for airframe labor and materials.

Engine overhaul time is now 450 hr. but Canadair is guaranteeing an engine overhaul cost on a 750 hr. basis—overhaul time expected to be reached within a year.

Cost of the airplane complete is $1.2 million. In this connection, Allegheny is backing legislation introduced in this session of Congress that would increase the government guarantee on loans to airlines from 90 to 100% and raise the limit of such loans from $5 million to $10 million.

Eland Overhaul

Overhaul of the Eland engines will be handled by Canadian Pratt & Whitney Aircraft Co. Later, Napier plans to establish four overhaul facilities throughout the U. S. to handle engine maintenance for carriers. Sites of the overhaul bases will depend on headquarters locations of operators who buy the airplane.

During the demonstrations, Allegheny officials expressed enthusiasm over the takeoff and landing characteristics of the Canadair. Napier officials told AVIATION WEEK that the plane fully loaded with 48 passengers will operate from runways of less than 4,000 ft. on stage lengths of less than 375 mi.

Some disappointment was expressed over the noise level in the cabin interior. Generally, it was agreed that the plane was not as quiet during cruise as most members of the flight had anticipated it would be.

The majority noted, however, that there was little or no increase in noise in the first two or three seat rows of the plane—a characteristic common to most turboprop aircraft.

FAA Certification

Certification of the aircraft by the Federal Aviation Agency was begun in January, 1958, and completed in Santa Monica in August. For certification purposes, the Eland engines—after 1,000 hr. flight time—were mounted on a Convair 340. Basic 200 hr. of certification flights and tests and the 100 hr. of functioning and reliability tests were completed without any hitch.

Use of the Convair on Allegheny's routes will fit into the company's basic pattern for growth as adopted in its applications for new routes. These basic philosophies, as outlined in the airline's report to stockholders, are:

- **Short-haul carriers must** be allowed to move into markets which have experienced a decline in the number of trips and seats available because of emphasis placed on long-haul markets by trunkline carriers during that time.
- **Elimination of operating** restrictions imposed upon Allegheny to protect trunkline carriers from more competition in areas not considered "feeder line" areas.

The carrier states that "these restrictions are outmoded and their elimination will not only improve service to intermediate cities, but will help reduce subsidy payments now required by these cities."

Barnes pointed to American Airlines as an example of the manner in which trunkline carriers should turn over their intermediate stations to local service carriers to permit stronger concentration on long-haul markets. Recently, Civil Aeronautics Board Member Harmar Denny praised American for its program in transferring these routes to local service carriers and said "the salvation of these (local service) carriers lies in turning over "substantial points to smaller carriers." He added, "I wish more of them (trunklines) felt the same way as American does."

Progress Need

In this connection, Barnes said that "the evolution of air transportation is ahead of the thing—the local service carriers—that created the evolution." He pointed out that the industry will catch up with the evolution only after route adjustments are completed for the local service carriers and new concepts of operating services are adopted to capture high-density traffic markets.

He said the trend by trunklines to reduce and withdraw from the short-haul markets will continue as more long-range turbojet and turboprop equipment is introduced. This equipment is designed to cover distances in excess of 300 to 400 mi., he said, adding that all city pairs sought by Allegheny in its CAB applications are under that distance.

Allegheny's net income for 1958 was $221,000 compared to a $153,000 loss in 1957 and a $197,000 loss the previous year. The company operating at a 51% load factor last year and carried 488,615 revenue passengers an average distance of 173 mi. for a total of 84 million revenue passenger miles.

707 Undershoot

Chicago—An American Airlines' Boeing 707-120 was scheduled to go back into service last week after repairs following a runway undershoot at O'Hare Field. The jet transport was making a scheduled stop in American's New York-San Francisco service via Chicago.

The 120's pilot landed in gravel just short of the runway after making an Instrument Landing System approach and breaking into the clear at about 600 ft. Damage resulted to tires, landing gear door and No. 2 engine pod. The pod was tilted after several shear pins broke off from the force of the landing, which was made in a stiff cross wind.

Crew, passengers and observers on the ground were unaware of the incident, the airline said, and the damage was discovered only when ground crews went over the airplane.

Second Convair 880

San Diego—Second Convair 880 turbojet transport made its initial flight last week in a one-hour 26-min. run and is now undergoing a nine-month proof-loading test at Convair structures laboratory. After an initial series of flight test work, the airplane, which is equipped with thrust reversers, will be used for a series of taxi tests to determine optimum setting for thrust reverse vanes.

One of the transports will be flown to Las Vegas April 11 for display and demonstration at the World Congress of Flight sponsored by the Air Force Assn. The other will be assigned to Air Force demonstrations at Edwards AFB, Calif., from April 15-20.

they said. Citing its load factors of as

Flight Plan Altitude Changes Slow

Airlines Renew Transpacific Route Battle

By Robert H. Cook

Washington—Attorneys and economists representing 11 carriers are scheduled to make their opening legal bids tomorrow for new and increased traffic rights across the Pacific at a prehearing conference of the Civil Aeronautics Board.

Completion of the conference will resolve both questions of proper carrier applicants and geographical areas to be served in a vast expanse of territory encompassing almost the entire Pacific area from the West Coast to the Far East and Australia.

Particular interest is being attached to this Trans-Pacific Renewal Authority Case as a result of a recent White House letter to the CAB requesting Board members to thoroughly explore the transpacific market potential and, where possible, include all pending carrier applications for separate areas of this territory within an expanded Trans-Pacific Case.

Most interest, however, already has been drawn to Pan American World Airways and Northwest Orient Airlines applications, with a final decision in the Trans-Pacific Case expected to settle a running legal battle of the past 10 years for control of the shorter Great Circle route to the Orient now used by Northwest as opposed to the longer Central Pacific route, via Hawaii, used by Pan American.

Both carriers received temporary transpacific certificates to Tokyo and beyond in 1946, with Pan American required to make a stop at Hawaii or Wake Island on any flights picking up or discharging traffic in Tokyo. Although Pan American contends that this restriction adds 800 mi. to flights departing from San Francisco, it has never been lifted by CAB. The Board later modified its order to permit the airline to use the Pacific Polar route out of Los Angeles and San Francisco.

However, this permission to fly the same, more direct route to the Orient as that used by Northwest has failed to prove of economic value since, Pan American contends, the Board did not include the Portland and Seattle stops served by Northwest.

Although removal of the Hawaii restriction is the key issue to Pan American's application, the carrier also is asking that New York, Chicago, San Francisco, Los Angeles, Seattle and Tacoma be named as coterminals on a transcontinental route to be operated without any intermediate stops between these cities and existing points on the carrier's present route system. In addition, the airline has asked CAB to add Fairbanks, Alaska, along with Okinawa and the Society Islands, as new intermediate points; extend its South Pacific route system to join the Central Pacific and add Moscow as a coterminal with points in India and Pakistan.

Northwest's basic want is to protect its permanent Seattle to Tokyo certification and retain its Pacific Polar route authorization from the cities of New York, Chicago, Minneapolis, Portland, Seattle and Anchorage and to add the cities of San Francisco and Los Angeles. In addition, the airline seeks CAB approval for service between Honolulu, Wake Island and points in Japan.

Leaning heavily upon its jet plans, Pan American contends that Northwest has failed to properly develop its "inside" Great Circle route connecting the 38 million population of the New York, Chicago and Minneapolis areas with the Orient. Approval of its requested domestic coterminals would permit Pan American jets to bring Tokyo within 13¾ hr. of these and other East and Midwest cities and place West Coast stops within 8¾ hr. of Tokyo, the airline claims.

While Northwest has not yet completed all formal replies which it will present to these charges, the airline contends that its inside route is less than 300 mi. shorter than Great Circle flights departing from Seattle. The Seattle route is used by majority of its passengers flying to the Far East.

Pan American, on the other hand, emphasized the importance of Fairbanks as an intermediate point in its planned jet service for Tokyo and beyond. Jet flights would depart from such points as New York, Washington, Detroit and Chicago, land at Fairbanks within seven hours and continue to Tokyo for arrival within an estimated eight hours. Seattle would be the departure terminal for West Coast nonstop flights to Japan.

Northwest has not made final plans for its own jet service to the Orient, but it has indicated that its first Douglas DC-8 aircraft will be pressed into immediate service. Delivery of its own jet fleet, Northwest officials say, will nullify any Pan American bids to provide any faster service over the transpacific,

BOAC Begins Round-World Service

London—British Overseas Airways Corp. last week began its around-the-world service with Bristol Britannias and de Havilland Comet 4s without waiting for Civil Aeronautics Board approval of the transpacific sector.

Meanwhile, in Washington, Board examiner hearings were completed the same day service began after CAB had denied a Northwest Airlines' petition for a stay in the proceedings (AW Mar. 23, p. 41). Chances are strong that the examiner's initial decision and a Board final decision granting BOAC a Tokyo stop on the transpacific route will be expedited.

BOAC has said that passengers on initial flights would be carried free between San Francisco and Hong Kong until CAB approval is granted. The carrier backed the inauguration of the new service with a U. S. promotional campaign that included advertisements showing Tokyo as a stop on the new route with a phrase that qualified the new route as being "subject to government approval."

Northwest has been the only U. S. carrier intervening in the case and has made three bids to defer a Board decision on the Tokyo stop without success. Two attempts by the Air Transport Assn. to intervene in the case were turned down by the Board.

Northwest Airlines has objected to BOAC's application to carry passengers from the U. S. across the Pacific on grounds that the BOAC service would be detrimental to its own interests and that of other airlines. Pan American, which also operates a transpacific route, has refrained from entering the case.

Northwest also contends that, by seeking to add Tokyo to its route system, BOAC is not abiding by section 4b of the Bermuda Agreement which, Northwest says, has been traditionally interpreted by both the British and U. S. governments to apply only to "points of limited significance."

Northwest holds that Tokyo, as one of the world's largest cities, does not fit into this interpretation. Also pending in the transpacific battle is the Qantas Empire Airways' case which calls for a legal opinion on "cabotage" or the right of a foreign carrier to transport international traffic between points within the U. S. (AW May 19, p. 38).

However, BOAC Chairman Gerard d'Erlanger, has made it clear that the British do not intend to have their plans for the service upset regardless of a CAB decision.

Scheduled time for the 25,000 mi. service is 86 hr., 50 min.

they said. Citing its load factors of as high as 97% on transatlantic runs, Pan American said the importance of placing a heavy jet schedule across the Pacific cannot be overemphasized. Ten years ago, U.S. flag carriers carried nearly 91% of the Pacific traffic as compared with current figures of only 67%, the airline said.

Across the Central Pacific, where Pan American competes with Japan Air Lines, the U.S. flag share is down to 52%, Pan American pointed out, adding that JAL has announced plans for a Tokyo-Seattle service this year via the Polar route and for extension of that service to New York by 1962.

Other carriers which have filed applications in the Trans-Pacific Case include Western, Flying Tiger, Seaboard & Western, Trans Ocean, South Pacific, Hawaiian, Continental, Trans World and Alaska.

TWA, Eastern Net Finances Off in 1958

New York—Eastern Air Lines and Trans World Airlines, both hit by strikes last year, showed less favorable net financial results during 1958 than in the previous year.

Eastern, affected not only by a 39-day strike but by unseasonable Florida weather, earned a net 1958 profit of $7,078,062, compared with a net of $9,378,022 in 1957. Last year's earnings included a $249,367 capital gain item, whereas a $2,515,260 capital gain was included in the 1957 figure. Operating revenues totaled $246,227,878 in 1958, down from $262,477,153 in 1957. Operating expenses totaled $234,950,769 as against $251,797,788 in 1957.

Load factor in 1958 was 53.1%, down from 60% in 1957. Eastern ascribes the reduction to the Florida weather and to "multiple competition imposed on Eastern's main trunk routes."

TWA made strong gains during the second half of 1958, showing a $10,196,000 operating profit for that period compared with an operating loss of $1,305,000 for the first half of the year. Operating loss for the entire year was $375,000, down from $4,539,000 in 1957 and 4,131,000 in 1956. The 1958 net loss of $1,764,000, compared with a net loss in 1957 of $1,558,000, was chiefly due to lesser gains on equipment sales, lower tax credits and other non-recurring items, TWA said.

The second-half 1958 comeback was attributed to flight schedule revisions and expense control programs. TWA sold 514,289,000 revenue ton-miles in 1958, an increase of 4.4%. Gross revenues totaled $284,841,000, an 8% rise over 1957.

Flight Plan Altitude Changes Slow American's Transcontinental Jets

By Glenn Garrison

New York—Better control of altitude in transcontinental jet operations is needed to avoid payload penalties and schedule delays, American Airlines has discovered during its initial jet service.

Altitude changes required by traffic control have extended many of American's cross-country Boeing 707-120 flights beyond scheduled time, M. G. Beard, assistant vice president-equipment research, reported in a paper scheduled for delivery last Friday to Society of Automotive Engineers members at their national aeronautic meeting here. With Trans World Airlines now operating jets transcontinentally and United Air Lines planning to join the competition next fall, the situation will become increasingly serious, Beard indicated (see p. 47).

Beard said a review of the off-to-on times of 57 American jet schedules showed 36% were 10 min. or more above planned times, 20% were 20 min. or more over, and 9% were 30 min. or more over. One flight was 1 hr. 21 min. over, and 10% of the flights were 10 min. less than scheduled time.

How much of this delay was caused by required altitude changes and how much by higher than anticipated headwinds will not be known until further analysis can be made, Beard said. Almost all overtime schedules, however, showed one or more changes in altitude from their flight plans.

American is revising its presale payloads on the run to reflect summer schedules based on seasonal winds and temperatures aloft. Winter presale payload was set at 24,500 lb. eastbound and westbound, Beard said, whereas summer payloads will be 22,800 lb. westbound and 29,000 lb. eastbound. Reductions in fuel reserves carried for traffic control unknowns are needed to prevent cutting into these payloads, Beard said.

Full fuel capacity of 103,957 lb. has been carried more often than anticipated, Beard said, because of the traffic control unknowns and the need for ample reserves to cope with changes in routing and altitudes. Flights are carrying over 5,000 lb. more fuel than preliminary planning indicated would be necessary for normal nonstop operation. About 38% of American's February flights and 15% of its March flights carried full fuel loads.

Experience with its jets has also shown more time required on the ground between ramp and takeoff, according to Beard. Piston time for taxiing, engine runup and traffic and weather hold before takeoff has averaged 12 min., whereas the comparable average for 52 jet schedules between Mar. 1 and Mar. 25 was 19.7 min. The westbound jet average was 21.1 min. and the eastbound average was 17.7 min. Beard ascribed this directional difference partly to longer taxiing distances at Idlewild and partly to New York area weather and traffic.

Beard said mechanical difficulties with the 707-120 have been normal for a new airplane, but that American had experienced more electrical wiring trouble and electronic equipment problems than had been anticipated.

The airline's jet schedules are based on use of maximum cruise thrust, Beard said. Reason is that domestic jet operation is "highly competitive in speed."

Very careful planning goes into the jet takeoffs, the American official said. The procedure includes a check of water pressure, engine rpm., tailpipe temperature and oil pressure after throttles have been advanced and the pilot is holding the brakes. Brakes are then released and the second hand of the clock starts simultaneously. At 100 kt. the clock is checked against the time on the check chart table, and if actual time is a few seconds over chart time the pilot must decide whether to abort or proceed with his takeoff. At sea level, on a standard temperature day, with full gross of 247,000 lb., time to 100 kt. is 32 sec. with water augmentation.

Brakes are held in takeoff position while water injection functioning has been checked at nearly full takeoff throttle. There has been some difficulty with water pump and valve failure, Beard said, and it is therefore advisable to check water feed into the engines before beginning the roll.

The airplane must actually be flown while at its higher landing and takeoff ground speeds, Beard said, particularly in crosswind operations. This is especially true laterally, because the swept-wing 707-120's low-slung outer pods can touch ground with 7 to 8 deg. of lateral roll.

Traffic control position reports are made over the same transcontinental check points for jets as are used for piston flights, and often one report cannot be completed before the next check point is passed, Beard said.

Backing up earlier explanations by the airline of its decision to use a third pilot (AW Jan. 19, p. 41), Beard said the pilot and copilot often have

their hands full handling communica- apparently was a metallic object gested. Such a unit would only be

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their hands full handling communications and flight planning even when the autopilot is on. The third pilot, or second officer, now performs the traffic watch through the windows while the other pilots are busy, and he also takes a pilot's seat when the captain or copilot leaves it temporarily. The third pilot also will act as backup for the flight engineer when that crewman leaves his station, Beard said.

Among the other reports to SAE's aeronautical meeting was a paper on Eastern Air Lines' Lockheed Electra turboprop, also scheduled for delivery last Friday.

Charles Froesch, vice president-engineering, said introduction of the Electra on Eastern's system involved considerable reorientation of procedures in both operations and maintenance.

Problems of transition are to be expected with new types of aircraft, Froesch said, although many of them could be eliminated by better attention to detail design and "the application of sound logic" during the design, development and testing stages.

Many difficulties experienced with the Electra's electrical systems have resulted, according to Froesch, from "flimsy" accessories and components such as switches, relays, rheostats and inadequate insulation and connections where the addition of "a few ounces here and there" would have prevented many failures. In some cases, the Eastern official said, this has been a matter of a "penny-wise and pound-foolish policy which the operator often has to correct at this expense."

Eastern had to remove an engine within a few hours of the delivery of its first Electra because of ingestion damage, Froesch said. Removal and overhaul cost over $10,000. The cause apparently was a metallic object dropped into the engine outlet scoop.

The "grueling grind" of 8-10 hr. of daily operation, Froesch said, would bring to light any weaknesses in design or improper maintenance and servicing features. The Allison 501-D13 engine, despite more than 100,000 hr. of satisfactory military operation, was suddenly found to develop compressor rubbing trouble, fuel control system difficulties and accessory failures, Froesch said.

Bugs in various Electra systems have been encountered, Froesch indicated, more or less in the normal pattern of new aircraft operation. Some of the problems have been minor in nature and readily repairable while others require a study program to determine the causes.

Froesch said the smoothness and freedom from vibration of turbine engines has accentuated any propeller imbalance and amplified vibratory effects. This is particularly true of the Electra with a comparatively low power loading and high propeller disk loading, in spite of 40 in. clearance between blade tip and fuselage, he said.

Electra airspeeds were limited recently pending investigation of some vibration problems (AW Feb. 23, p. 37).

Froesch said the highest time so far on any of Eastern's Electras is about 700 hr., hardly enough to analyze the experience with each component. Several items, however, must receive further attention, he said. Among them is the engine starting system, which requires a ground power truck costing from $15,000 to $25,000 per unit. This he called "an economic waste."

An auxiliary power unit aboard the aircraft to provide both engine starts and electrical requirements might be a solution to his problem, Froesch suggested. Such a unit would only be started prior to landing and during takeoff until gear was retracted.

Other problems needing solution, he said, are prevention of corrosion to compressor and turbine blades and other engine parts, simplification of the electrical system and its protection against damage, including proper protection against electrical fires.

Eastern has gone through its transition period to turbine aircraft without serious incident, Froesch said, "except for departure delays which so annoy the customers."

American Selling 45 DC-6s to F. B. Ayer

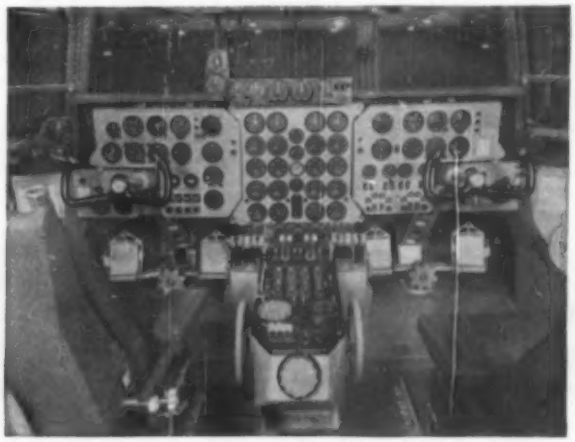
New York—American Airlines has contracted to sell 45 of its 81 Douglas DC-6 series piston aircraft to Frederick B. Ayer and Associates, aircraft dealer which already has bought 30 of American's Convair 240s. The latest agreement also gives Ayer first right of refusal for the remaining DC-6s.

Over-all value of the first DC-6 sale is $30 million, according to American.

The airline thus has arranged to dispose of 114 piston planes, more than half its fleet of 18 months ago. Delivery of the DC-6s to Ayer will be made as the planes are phased out of American's operation, with final delivery scheduled for January, 1961.

Included in the DC-6 sale are 80-passenger, 54-passenger and 60-passenger DC-6s; 62-passenger DC-6Bs; and five DC-6A cargo airplanes. All the planes will be from two to eight years old. Engine, propeller and airframe times will be less than 500 hr.

Ayer has bought 80 aircraft since last September and sets their purchase value at $40.5 million.



AW 650 Simultaneously Loaded Fore and Aft

Twelve tons of freight are simultaneously loaded through fore and aft cargo doors of the turboprop Armstrong Whitworth AW 650 Argosy (left). Six tons of freight are being winched into the forward door while another six tons are being loaded in the aft door. Controls and instrumentation layout of the AW 650 are at right. Riddle Airlines has signed a provisional order for four AW 650s.

Takeoff Power Responsibility Given to Engineers by Eastern

Washington—Eastern Air Lines' flight engineers have been given full responsibility for takeoff and climb power settings on the Lockheed Electra in the latest step by the airline to reduce its growing problem of premature engine removals (AW Mar. 23, p. 31).

Eastern has been experiencing an interunion dispute between some of its pilots and engineers, in which engineers claim pilots are endangering flight operations and creating maintenance problems by assuming many engineering duties.

Eastern's premature engine removals for both piston engine and turboprop equipment in January were triple the number recorded for the same month last year. Despite repeated advisories to flight crews from the company's maintenance department, premature removals for February exceeded those of January, which were characterized by Eastern as "an operational problem of the first magnitude."

Citing a compilation of more than 200 complaints filed by the Flight Engineers International Assn. with the Federal Aviation Agency, the engineers claim pilot unfamiliarity with correct flight engineering procedures is the key to much of the current maintenance problem. The problem has been most apparent in reports of overboosting of engines on takeoff and inability of pilots to maintain correct cylinder head temperatures, they say.

Eastern spokesmen admit the maintenance problems exist and observe that the figures "would suggest abuse" of engine operating procedures, but they deny there is any concrete connection between the rise in premature engine removals and current arguments between pilots and engineers. Primary cause of the trouble, Eastern said, has been the expected aftermath of the grounding of flight equipment during the recent strike by the International Assn. of Machinists and the FEIA.

Most of the premature removals for piston engines have involved the Curtiss-Wright Turbo-Compound engines used on Lockheed 1049C and G Constellations, the airline pointed out. Company directives calling attention to removals and in-flight failures on this powerplant are part of a continuing training program the airline instituted three years ago to monitor operation of this engine, Eastern said.

Nonetheless, the carrier has specifically told its flight crews that the flight engineer will be responsible for setting both takeoff and climb power on the Electra. Its notice states that the engineer will also monitor temperature and horsepower on the Allison 501D-12 engines and points out that the manufacturer's warranty on the powerplants specifies they will not be operated in excess of 971C for turbine inlet temperature on takeoff and 4,000 hp. Eastern reported 19 in-flight featherings of Electra engines for this February as compared with only 11 for the previous month of this year.

Premature removals for piston engines totaled 68 in February, as compared with 55 in January. In-flight featherings dropped from 57 in January to 50 in February. However, the airline said the decrease in featherings was due primarily to intensified line maintenance, designed to spot faulty engines before they fail. Many removals from these inspections have been for cylinder changes, oil consumption and supercharger failure.

"If we add cylinder changes to these figures, we have a staggering amount of trouble and the trend is toward further deterioration," the company told its flight personnel.

In a seven page report to all captains, pilots and flight engineers, Eastern spelled out many of its maintenance problems, offered correct operating procedures to avoid further trouble and observed that "it is a matter of record that non-standard and widely varied procedures can bring a major carrier to the verge of bankruptcy."

Comet 4 Claims Intercontinental Flight Record

Fastest flight from England to South America was claimed by an Aerolineas Argentinas de Havilland Comet 4 on a delivery flight in March. Elapsed time from takeoff at Hatfield, England, to overhead Buenos Aires was 18 hr. 23 min. Touchdown occurred 25 min. later. Distance flown was 7,075 stat. mi.; average speed was 385 mph.

BEA, Aeroflot Sign London-Moscow Pact

London—British European Airways and Aeroflot will begin the first direct scheduled service between London and Moscow this summer.

The Anglo-Soviet air services agreement drawn up in February was signed last week in Moscow.

BEA says it hopes to begin service early in the summer but not before the middle of May, in any event. No starting date has yet been agreed upon with the Russians.

Aeroflot's twin jet Tu-104 will operate into London Airport under initial restrictions which will be reviewed after sufficient operating experience is gained with noise conditions.

BEA plans to begin service with Viscount 806 airliners, shifting to Comet 4B jets after their entry into service in April, 1960. Both airlines are planning to operate two flights weekly in each direction with a stop at Copenhagen.

Other western airlines now serving Moscow include KLM, SAS, Sabena, Air France and, from the east, Air India.

Westland Opening London Heliport

London—London's first heliport, being built by Westland Aircraft, Ltd., on the River Thames at Battersea, will open April 23.

Traffic handling facilities will start operating the following day, but since the heliport initially is being operated under private license, operators must give brief prior notice of intent to use it, the company says.

Services will include radio communication and navigational aids, refueling and towing and parking for six medium-sized helicopters. A central administration building will provide passenger facilities. Customs and immigration clearance for passengers and freight can be arranged if prior notice is given.

The company is planning installation of lighting sufficient for landings and takeoffs at night, but the heliport will initially operate during the day.

Western's First Lockheed Electra Nears Roll-Out

First of nine Lockheed Electra turboprop transports being built for Western Air Lines nears completion at Lockheed Aircraft's Burbank, Calif., plant. Aircraft will be delivered about June 1; initial service is scheduled for August after delivery of third Electra.

CAB Requests New Legislation To Establish Inspection Rights

Washington—Civil Aeronautics Board has asked Congress for legislation giving it clear authority to inspect the records and memoranda of airline trade associations.

In a statement to Sen. Warren Magnuson (D.-Wash.), chairman of the Senate Commerce Committee, CAB Chairman James R. Durfee said that although the Federal Aviation Act gives the Board authority to inspect airline records, "there is doubt as to the authority of the Board to examine the books and records of persons controlled by an air carrier, under common control with an air carrier, or of service organizations controlled by groups of air carriers."

CAB recently launched a full-scale inspection and review of Air Transport Assn. (AW Mar. 30, p. 42). ATA has not challenged the Board's legal authority to subpena its records.

Other legislation requested by CAB for the first time this year, and introduced by Sen. Magnuson, proposes:

• **Penalties for "scalping** on airline tickets. The Board said that the practice "has grown to such an extent as to constitute a substantial burden on the orderly development of interstate air transportation.

"The adverse effects of the practice are particularly evident on the most heavily traveled routes, such as that between New York and Miami," the Board said. However, with the increasing demand for air transportation throughout the country, it may be expected that these practices will increase, to the expense and annoyance of the traveling public, unless effective measures are taken to put a stop to them."

The common pattern disclosed by Board investigations is for an individual to make reservations in anticipation of a heavy travel demand, and then sell the tickets, plus a premium on gratuity, generally ranging from $5 to $50.

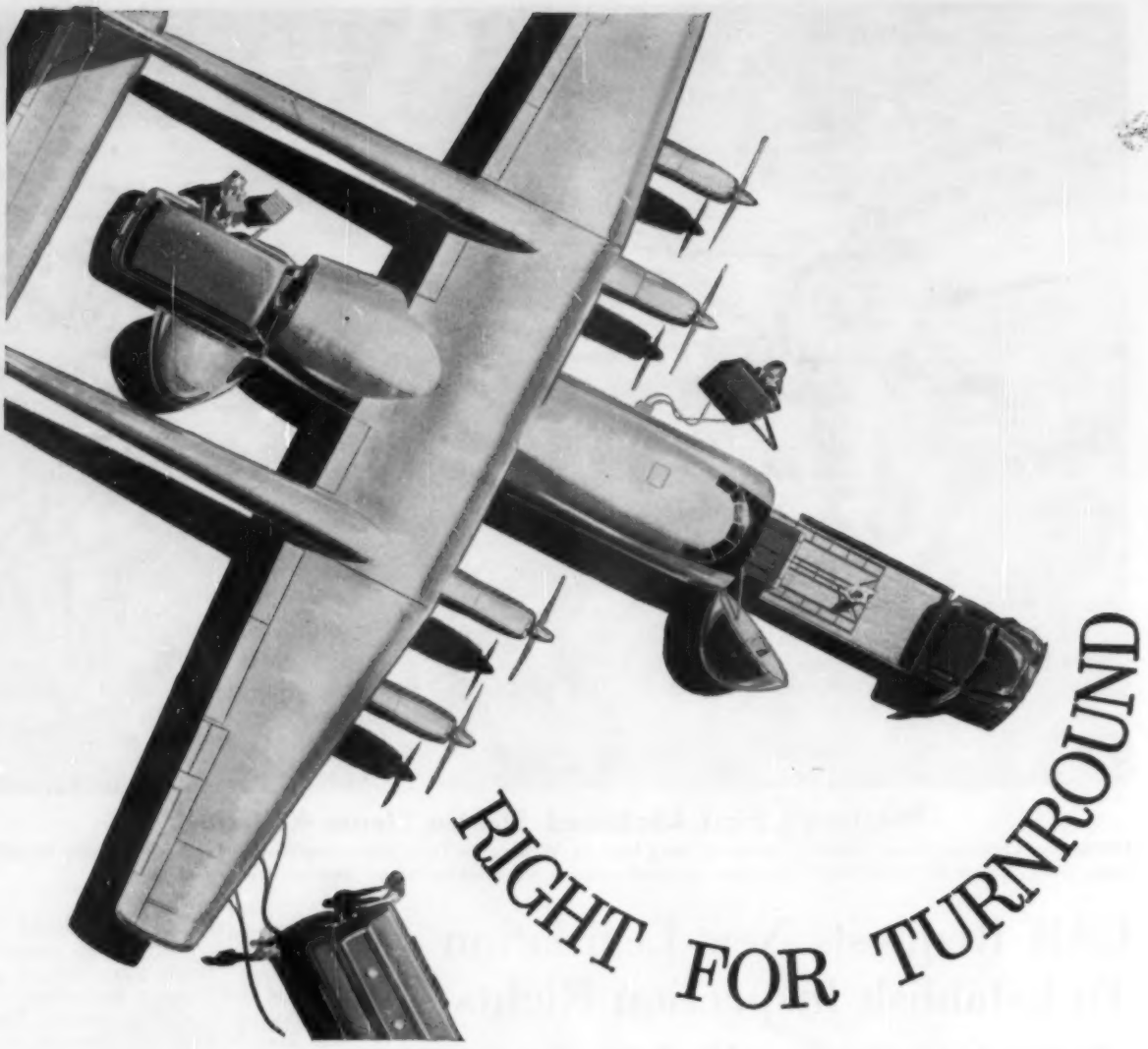
• **Declare a congressional policy** that the Department of Defense should not enter into competition with commercial airlines. Airline representatives are skeptical that a policy declaration will be effective in shifting military business from Military Air Transport Service to commercial carriers.

• **Authorize CAB** to regulate the depreciation accounting of air carriers. A U. S. district court in a recent case—Alaska Airlines versus CAB—upheld the Board's authority to do this, but the decision was reversed by the U. S. Court of Appeals, and the Supreme Court declined to hear the case.

Noting that depreciation is becoming an increasingly important operating expense for air carriers with the addition of new and more expensive aircraft equipment, CAB said that "improper charges to expense for depreciation would undermine the integrity of the financial statements in exactly the same manner as inaccurate charges for salaries, rents, and other operating expenses of the carriers."

• **Permit the Board to make** independent representations in court proceedings. CAB now must work through the Attorney General.

• **Permit the Board to dispense** with hearings in cases where they are not



RIGHT FOR TURNROUND

BIG FORE-AND-AFT DOORS AT PERFECT LOADING HEIGHT ENABLE THE ARGOSY TO LOAD AND UNLOAD WHOLE CARGOES IN UNDER 20 MINUTES

The less you handle cargo the cheaper the transport operation. This is true particularly of air freight where quick turnround is essential if costs are to be kept to a minimum. With the Argosy (AW650) a loading system is being developed that will enable the huge freight hold to be cleared and filled again in a few minutes. With full-width doors at either end of the fuselage, the load can be discharged at one end while new cargo is being loaded at the other.

High pressure refuelling ensures that a turnround can be completed in under 20 minutes. If the Argosy is used for mixed traffic—a role for which it is particularly suited—passenger and freight loading take place simultaneously.

The use of well proven components, particularly the Rolls-Royce Dart prop-jets, promise exceptional utilisation for round-the-clock operations.

PERFORMANCE

POWERED BY 4 ROLLS-ROYCE DART PROP-JETS

AIRCRAFT CRUISING SPEED: (14,000 r.p.m.) 296 m.p.h.
MAXIMUM PAYLOAD: 27,000 lb.
RANGE WITH FULL FUEL RESERVES AND 20,000 lb. PAYLOAD: 1,000 st.m.
SIZE OF HOLD: 46 ft. 8 in. (14.23 m.) x 10 ft. (3.05 m.)
FLOOR AREA: 426 sq. ft. (39.6 sq. m.)

THE ***Argosy*** BRINGS THE COST OF AIR FREIGHT DOWN TO EARTH

DESIGNED AND BUILT FOR THE HAWKER SIDDELEY AVIATION DIVISION BY SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD

sought by anyone with a substantial interest. In many simple transactions, such as the least of a limited number of aircraft, CAB said, the hearing serves no useful purpose.

• **Exempt Board Personal** from testifying as expert witnesses in litigations involving accidents the Board has investigated. Factual information developed by the Board would be made available to litigants to the extent it is not reasonably available elsewhere.

Other measures requested by CAB have been sought for several years by the Board, but never enacted by Congress. They include:

• **Increase in penalties** for violations of CAB economic violations. Criminal penalties would be raised from $500 maximum for a first offense and $2,000 for a repeated offense, to $5,000 maximum for a first offense, with each subsequent day of violation being considered a separate offense. Civil penalties up to $1,000 would be introduced for minor violations. ATA has opposed civil penalties on the grounds that they could "nickle and dime the airlines to death."

• **Authorize CAB to provide** certificates for limited types of services.

• **Separate by law airline pay** for carrying mail from subsidy payments.

• **Permit airlines to offer** free or reduced transportation to retired personnel and their families.

• **Authorize the Board to regulate** the rates of U. S. carriers in international service. It already has the authority for domestic rates.

Jet Control Procedures Outlined by FAA Unit

Washington—Present air traffic control procedures can be applied to turbojet transports without impairing efficiency or safety of flight operations, according to a preliminary report on tests conducted by the Technical Development Center.

The report pointedly refutes theories that jet aircraft will require high-altitude holding patterns in high-density terminal operations—a procedure once considered essential as a fuel-saving measure. It also proposes new concepts in the field of arrival scheduling control that can be applied in the development of equipment design and operational philosophies in future air traffic control systems.

The report is based on findings resulting from air traffic control simulation tests conducted by the Technical Development Center of the Civil Aeronautics Administration prior to its integration into the Federal Aviation Agency. Highlights of the report are:

• **Low-altitude holding** patterns permit higher efficiencies of approach systems

Eliminate fire hazard with

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AEROWASH-A IS NONFLAMMABLE! Has no flash point—diluted with water, or used straight. And with AEROWASH-A, solvent recovery is unnecessary—there's *no waste disposal problem!*

AEROWASH-A IS VERSATILE! Cleans all exterior surfaces of aircraft. Excellent for interior surfaces, too . . . won't craze plastics. AEROWASH-A removes jet-engine exhaust stains.

AEROWASH-A IS APPROVED! Meets Air Force requirements.

AEROWASH-A IS PLEASANT TO USE! Non-toxic, mild on skin, no obnoxious fumes. May be used indoors! Does not harm asphalt ramps and runways.

For more details on AEROWASH-A—or information on Wyandotte's other aircraft-cleaning products—call your Wyandotte representative. Or mail the coupon below. *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Also Los Nietos, California. Offices in principal cities.*

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- ☐ Carbon Removal
- ☐ Metal Cleaners
- ☐ Removing Exhaust Stains
- ☐ Chemical Products for Airframe Manufacture
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- ☐ Chemical Milling Aluminum and Magnesium

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Firm_____

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City_____ Zone_____ State_____

Qantas Nears Start of Boeing 707 Intercontinental Service

Qantas Empire Airways, the Australian airline, will start Boeing 707-420 jet transport service from New York to London July 29 and to Australia July 31. A Qantas 707-420 also will arrive in New York July 29 from Sydney, en route to London.

than high-altitude holding patterns. Resultant reduction in delays will more than compensate for the increased fuel-flow rates of jet aircraft flown at low altitudes in high-density terminal areas.

• **Tunnels should be used** instead of detours in cases where jet transports cannot be cleared for unrestricted climb.

• **Development of advanced** approach systems using preassigned landing reservations will reduce amount of low-altitude holding without reducing acceptance rate of the approach system.

• **Path-stretching was found** to be the most precise method of adjusting approach intervals.

• **Emphasis was placed** on the need for a thorough understanding by operations personnel of civil jet aircraft operating characteristics and limitations to ensure efficient integration of jets into the present air traffic control system.

The report noted that simulation tests indicated high-speeds of jet aircraft will present a problem to controllers who are not experienced in handling jets because of higher rates of closure with other aircraft and the low turning rates required for passenger comfort. It added that one of the most important jobs the controller will have will be to become accustomed to "staying ahead of the aircraft" and to the increased operating tempo of jet flights.

The report pointed out that the high rate of fuel consumption will make it desirable for pilots to complete pre-takeoff cockpit checks prior to starting engines. It also said that "it may become common practice for jet pilots to secure their ATC clearances before leaving the ramp."

In this connection, since no engine warmup is required for turbojets, the report recommended a bypass taxiway for the jets to permit an uninterrupted run to takeoff position. The report said a four-engine turboject, taxiing at 50 rpm., will burn 140 lb. of fuel per minute.

As a means of adjusting arrival time of each aircraft so it meshes smoothly into the stream of arriving traffic, the report recommended velocity control and preassigned departure time as basic techniques to be added to the holding and path-stretching systems now in general use.

The report was prepared by Paul T. Astholz and Tirey K. Vickers of the Federal Aviation Agency.

Airport Incident

New York—Port of New York Authority is being sued by a 21-year-old youth and his brother who went to Idlewild to see the sights and found themselves involuntarily needled by Public Health Officials. The youths left the observation deck at the International Arrivals Building by an emergency stair, wound up mingling with a stream of arriving international passengers. Since they had been exposed to possible foreign infection, Public Health insisted on giving them shots. Their objection to the injection is priced at $6,000 each.

Jet Financing Bill Proposed by ATA

Washington—Legislation advocated by the Air Transport Assn. to facilitate the financing of jet fleets appears to be non-controversial in Congress. The two provisions of the measure would:

• **Enable airlines to issue** a valid security interest in specifically identified propellers installed in aircraft. This may be done at present with respect to engines.

• **Exempt holders of security** interests in engines and propellers from liability. Holders of security interests in complete aircraft are already exempt from liabilities arising from accidents or other causes in the operation of the aircraft.

At hearings last week before the Senate Commerce Subcommittee headed by Sen. Mike Monroney (D.-Okla.), J. D. Durand, assistant general counsel of ATA, said "several" airlines intend to lease jet engines and propellers. "One member has pointed out that leasing propellers for its turboprop fleet will reduce by $1.5 million its need for capital funds and is an absolute necessity if its financing of jet equipment is to be consummated," he said.

Manufacturers are unwilling to lease propellers, Durand said, unless their security interest is duly and specifically protected.

Financing agencies are also unwilling to separately finance engines or propellers unless they are exempted from liability arising from the operation of the equipment, Durand pointed out.

The measure also was endorsed by the Federal Aviation Agency, Aircraft Industries Assn., and the General Aircraft and Leasing Co. Brackley Shaw, representing the leasing firm, proposed an additional provision—that security holders be protected from liabilities arising from incidents occuring in the air as well as on the ground. The present exemption, applying only to ground crashes or other surface incidents, Shaw said, offer the security holder no protection from liabilities arising from mid-air collisions.

SHORTLINES

▶**American Airlines** increased its Boeing 707-120 transcontinental nonstop New York-Los Angeles flights from two to three daily April 1. The new flight leaves New York's International Airport at 11:45 a.m. and arrives Los Angeles at 2:15 p.m. Return flight leaves Los Angeles at 3:00 p.m. and arrives New York at 10:30 p.m. All times are local. American will begin Lockheed Electra service to Chicago from Washington April 12, with two round trip flights daily, and intends to increase frequency of flights as new Electras are delivered.

▶**Northwest Airlines** carried 118,770 domestic passengers during February, a 22.8% increase over the same period last year. Total revenue passenger miles flown for February were 108,712,000, up 43.9%. Breakdown for international and domestic passenger miles is 20,407,000, up 24.2%, and 88,305,000, up 49.4%, respectively. During February, Northwest showed a net loss after taxes of $169,127.

▶**Pan American World Airways** has carried 50,000 passengers between the U. S. and Europe on its Boeing 707-120 aircraft. Only three of Pan American's six jets were needed on the run.

▶**Seaboard & Western Airlines** has opened new sales offices in San Francisco and Atlanta. The carrier now operates on routes to Europe from the U. S., but has applied for permanent cargo and mail routes from San Francisco/Oakland to the Far East and southwest Pacific. Airline has recently been involved in the Pacific Airlift between San Francisco and Tokyo. It carried some 30 million lb. of cargo, mail and passengers on 2,500 flights across the Pacific.

▶**Trans World Airlines** flew 265,433,116 revenue passenger miles on its domestic routes during February for a 14% increase over the same period last year. TWA attributes much of the increase to the newly opened St. Louis-Miami routes and nonstop service on East to West Coast service. During the first week in March, 1,500 persons booked reservations on TWA's flights to Europe for the period prior to June 1–35% higher than the previous week.

▶**United Air Lines** flew 344,245,000 revenue passenger miles during February for a 10% increase over the same period last year. Mail ton-miles rose 13% to 2,653,000, freight ton-miles rose 27% to 5,383,000 and express carried was 838,000 ton-miles, up 21%.

AIRLINE OBSERVER

▶Federal Aviation Agency Administrator Elwood Quesada has instructed regional administrators, attorneys, bureau of flight standard chiefs and supervising inspectors to tighten up enforcement activities. In an unprecedented meeting in Oklahoma City, FAA personnel were warned against any relaxing of enforcement of civil air regulations and were given what Quesada calls the "Four F" formula as a guide in conducting enforcement proceedings. Four F's are fast, factual, fair and firm.

▶**Western, Eastern and Presque Isle Air Defense Identification Zones (ADIZ) running vertically across the U. S. were eliminated last week and flight requirements within the remaining zones were relaxed. Elimination of the three ADIZs became possible with the complete encirclement of the U. S. border zones with the establishment of an added ADIZ from the Gulf of Mexico to the Pacific. Remaining encircling zones are designated Atlantic, Gulf of Mexico, Pacific and Canadian border. Pilots now flying in any of the remaining ADIZs will no longer be required to file defense visual flight rules when operating at a true air speed of 150 kt. and 3,000 ft. altitude or less. Formerly, pilots were not required to file a DVFR flight plan when operating at 100 kt. below 1,500 ft.**

▶Civil Aeronautics Board has agreed to hold its subpena directed to the president of the Air Transport Assn. in abeyance (AW Mar. 30, p. 42). Subpena was issued when ATA gave only "restricted access" to its files in the current CAB review and inspection of the association. The Board said it found it appropriate to hold the subpena in abeyance because of an "unqualified statement" by ATA that it would cooperate in the future with the Board in the investigation.

▶**Load factor for seven local service carriers during February reached 42.3%, an insignificant gain over the 41.9% recorded in the same month last year. Available seat miles for the seven airlines rose from 70 million to 78 million while revenue passenger miles climbed from 29 million to 33 million in the same period.**

▶Significance behind the forecast American Airlines' President C. R. Smith made of 1959 revenues lies in its departure from his custom not to make such specific forecasts in speeches. American, like a number of other airlines, has shown interest in broadening its equity base now that airline stock prices have risen above book value. Since the end of 1958, American's stock has risen from $24 a share to over $30, the highest price for American's shares since a split in 1946. Smith predicted revenues would exceed $360 million, compared with $316 million in 1958, which should not dampen any market enthusiasm for American's securities.

▶**Trans World Airlines switchboard operators are answering calls with something of a speech: "Good morning, TWA jets you to California." BOAC is more general: "Good morning, the jet airline, BOAC." Pan American and American have nothing to say about jets but National opens conversations with "Fly National Jetstars." United has quietly dropped its "the radar line." All carriers continue to cling to one traditional opening remark: "Reservations are busy, will you kindly wait?"**

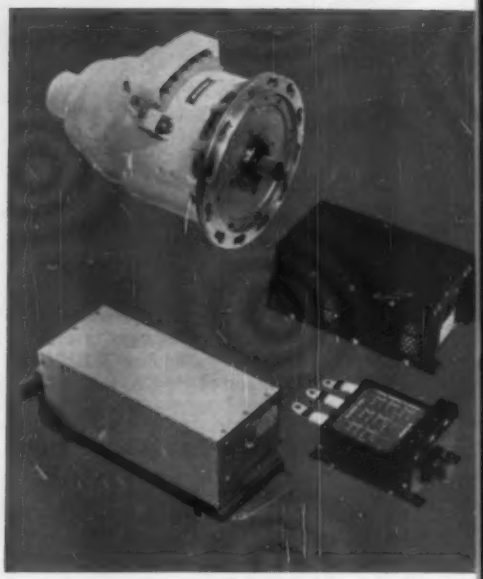
▶Some of Russia's four-turboprop An-10 Ukraina transports may be equipped with compact, folding passenger loading stairs which will be carried in the baggage compartment near the cabin's forward door for use when the planes land at "unequipped" airports. The An-10's high-wing design and low-slung fuselage permit utilization of much smaller loading stairs than are required for the Tu-104, Il-18, or even the piston-engine Il-14.

▶**Military Air Transport Service has awarded contracts to nine commercial air carriers to fly passengers and cargo overseas during April, May and June. Carriers receiving awards are Flying Tiger, Pan American, Alaska, Transocean Airlines, Slick Airways, Capitol Airways, United States Overseas Airlines, Overseas National Airways and Seaboard and Western.**

CAPABILITIES FOR DEFENSE

Westinghouse electrical systems, using first brushless generator, proved in thousands of flight hours

NOW IN FULL-SCALE PRODUCTION. The world's first aircraft brushless generators have a key role in advanced electrical systems provided by Westinghouse for today's military and commercial aircraft. The 40 kva units above are standard in Boeing 707 jetliners. First introduced in 1954 by Westinghouse Aircraft Equipment Dept., Lima, Ohio, these dependable generators have performed thousands of flight hours on the Boeing 707 and the Air Force B-58.



LEADER IN AIRCRAFT ELECTRICAL SYSTEMS. Westinghouse has been producing aircraft electrical systems since World War I—has built more a-c electrical systems for aircraft since World War II than any other company. Shown is the brushless air-cooled generator with control apparatus.

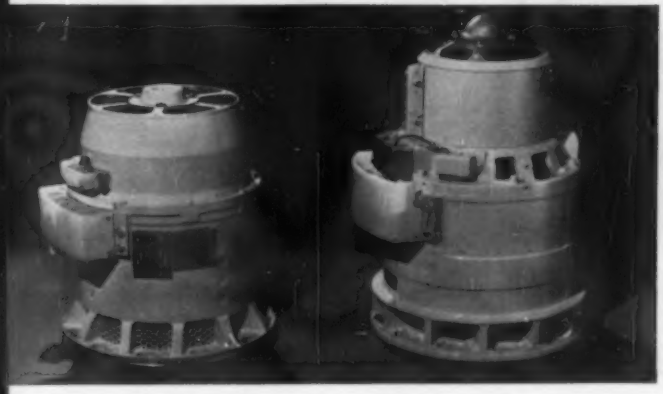
NAVY—The North American A3-J, completing flight tests preparatory to joining the fleet, uses the Westinghouse electrical system, including oil-cooled brushless generators.

AIR FORCE—The Convair B-58 Hustler employs the Westinghouse electric power system, including oil-cooled 40 kva brushless generators.

LONGER SERVICE LIFE and greater reliability result from the elimination of commutators, carbon brushes and collector rings, shown at right. A single internal rectifier bundle, held by girl, replaces them. High-temperature silicon diodes, produced by Westinghouse research in semiconductors, make this possible.

OIL-COOLED GENERATOR for Convair B-58 Hustler achieves major breakthrough of temperature barrier in electrical generator design—is cooled by MIL-L-7808 oil, having inlet temperature of 300° F. Usual generator troubles are eliminated—no brushes, commutating or slip-ring parts to wear. Results: greater economy, less frequent overhaul.

AUTOMATIC FUNCTION SIMULATOR, one of the newer testing techniques used by Westinghouse, assures more reliable protective devices for electrical systems. This machine subjects protective control panel to as many situations as it will encounter in flight operations.



BRUSHLESS VERSUS BRUSH-TYPE GENERATOR. Both generators are 40 kva. The brushless generator on the left above uses less space and weighs less. Longer life is assured—air-cooled brushless generators are guaranteed for 3,000 flight hours, bearings up to 1,500 hours. Brushless generators with even greater life are under test at Westinghouse.

ROBOT CIRCUIT TESTER uses punched tape to check circuitry of control equipment with 100% accuracy, 60 times faster than previous techniques. Westinghouse automatic circuit-testing facilities speed production, eliminate chance of human error, improve product reliability.

COMMERCIAL—The Boeing 707 uses Westinghouse electrical system, including air-cooled brushless generators—proved in thousands of flight hours.

Westinghouse

DEFENSE PRODUCTS

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ELECTRONICS DIVISION
AIRCRAFT EQUIPMENT DEPARTMENT
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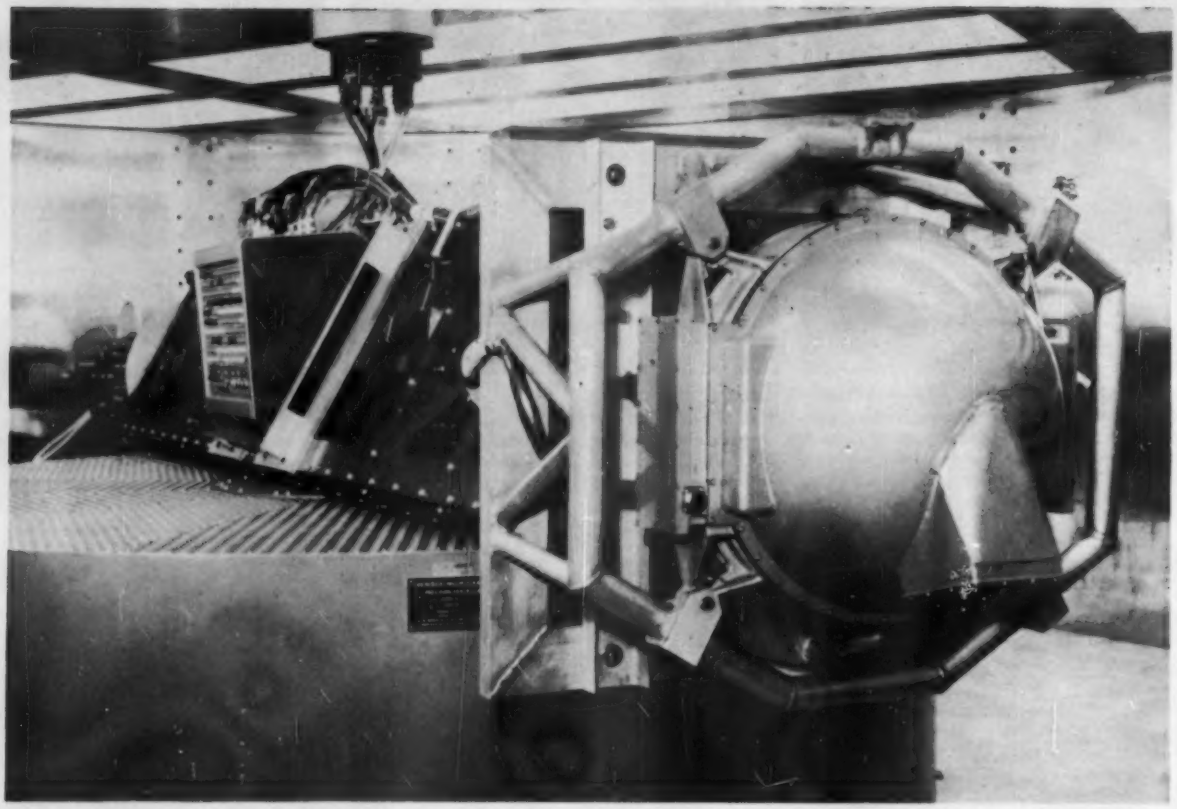


INERTIAL GUIDANCE system for Atlas intercontinental ballistic missile, developed by American Bosch Arma Corp., is shown undergoing high acceleration tests on large centrifuge. Sphere at right contains the gyro stabilized platform, heart of the system.

Inertial Guidance Sales Show Fast Climb

By Philip J. Klass

Washington—Nearly a quarter of a billion dollars worth of inertial guidance systems were produced last year by U. S. manufacturers and the figure is expected to be 50% higher in 1959, an AVIATION WEEK survey has disclosed. By 1963, manufacturers expect to be producing more than $600 million annually in inertial systems, the survey indicates.

This represents a remarkable growth for a product which didn't exist a decade ago and which had only begun to emerge from the laboratory five years ago. Figures do not include sales of inertial components, such as gyros, stabilized platforms used for flight instrumentation, stabilization and fire control.

Fast-rising sales figures reflect the fact that inertial systems have now become the dominant guidance technique for surface-to-surface and air-to-surface missiles and are coming into use for mid-course guidance of surface-to-air and air-to-air missiles.

Explanation for the increasing popularity of inertial guidance over radio guidance is the former's complete invulnerability to enemy jamming and countermeasures. Another reason, in the case of ballistic missiles, is the ability to launch mass salvos and the ease of constructing hardened bases without need for external antennas.

Inertial Systems

Inertial systems also are finding increased use in aircraft for bombing and navigation, not only because of their jamming invulnerability but because they, unlike radar, give no tell-tale electromagnetic radiation to warn the enemy of approaching aircraft. Even interceptor aircraft are being outfitted with inertial navigators to make them more independent of ground-based navigation aids.

At present, fewer than 20 companies dominate the inertial systems field. Only a handful of these hold the bulk of current systems production. These include AC Spark Plug Division of General Motors, producing for Douglas Thor and Martin Mace missiles; American Bosch Arma, producing for Convair Atlas and Martin Titan; Ford Instrument, producing Chrysler Redstone and Jupiter guidance. In the aircraft field, Sperry is the major producer of inertial bombing-navigation systems for the Convair B-58, and Kearfott of inertial navigators for use on interceptors and early warning aircraft.

These ranks will shortly be joined by North American's Autonetics Division which holds contracts for inertial system production for the North American Hound Dog air-to-surface missile and for the new USAF Minuteman missile, and by General Electric which will manufacture guidance for Navy's Polaris intermediate range ballistic missile. The latter system is being developed by Massachusetts Institute of Technology.

Northrop's Nortronics Division, one of the first to produce inertial systems in quantity for the Snark, should also be included in the foregoing list al-

Inertial Guidance System Applications and Design Characteristics

VEHICLE	TYPE OF SYSTEM			PLATFORM DESIGN			TYPE OF GYROS					TYPE OF ACCELEROMETER		TYPE OF COMPUTER			APPROXIMATE SYSTEM WEIGHT	SYSTEM STATUS			MANUFACTURER
	Pure Inertial	Stellar-Inertial	Doppler-Inertial	Three-Gimbal	Four-Gimbal	No Gimbals	Single-Axis	Dual-Axis	Liquid-Floated	Air-Bearings	Other	Non-Integrating	Single-Integration	Analog	Digital	Analog-Dig. Combination		In Development	Prototype Test	In Production	
MISSILES:																					
Redstone	X			X			X			X			X	X			680 lb.			X	Ford Instrument
Jupiter IRBM	X			X			X			X			X	X			450 lb.			X	Ford Instrument
Thor IRBM	X			X			X		X				X	X			500 lb.			X	AC Spark Plug
Atlas/Titan ICBM	X			X				X	X				X		X		*350 lb.			X	Arma
Minuteman ICBM	X			?				?		?			?		?		*200 lb.	X			NAA Autonetics
Polaris IRBM	X			?			X		X				?		X		*150 lb.		X		M.I.T./GE
Sergeant	X			?			?		?			?				?	*150 lb.		X		Sperry Gyro
Pershing	X			?			?		?				?			?	*150 lb.	X			Eclipse-Pioneer
Snark		X		X			X		X			X			X		*750 lb.			X	Northrop Nortronics
Mace	X			X			X		X				X	X			500 lb.			X	AC Spark Plug
Hound Dog	X			?													N.A.		X		NAA Autonetics
†"A"	X			X				X	X			X		X			N.A.		X		Bell Aircraft
"B"	X			X				X	X			X			X		N.A.	X			Bell Aircraft
"C"	X					X	X		X			X			X		45 lb.	X			Internat. Tel. & Tel.
"D"	X					X	X		X			X			X		75 lb.	X			Internat. Tel. & Tel.
"E" (ASM)	X				X		X		X				X		X		145 lb.		X		Minn.-Honeywell
"F" (SAM)	X				X		X		X			X		X			85 lb.	X			Minn.-Honeywell
"G"	X				X		?		?			?			X		100 lb.		X		Northrop Nortronics
AIRCRAFT:																					
B-58			X	X			X		X				?	?			N.A.			X	Sperry Gyro
B-70			?	?				?		?			?		X		N.A.	X			NAA Autonetics
F-104/F-106	X			X			X				X	X		X			100 lb.			X	Kearfott
RC-121/WV-2	X			X			X				X	X		X			185 lb.			X	Kearfott
Navy Interceptor	X				X		X		X				X	X			285 lb.		X		Minn.-Honeywell
Navy Interceptor			X		X		X		X				X	X			N.A.	X			Minn.-Honeywell
Navy Interceptor	X				X			X	X			X			X		65 lb.	X	X		Litton Industries
†"H"		X	X		X		?		?			?			X		200 lb.		X		Northrop Nortronics
**X-15	X				X		X		X			X		X			135 lb.			X	Sperry Gyroscope
Dyna-Soar	X				X		X		X				X		X		N.A.	X			Minn.-Honeywell

* Estimated
** Not complete guidance system
† Application not disclosed
N.A. Not available
? Not confirmed

though latter production is now tapering off.

The 11 inertial system manufacturers who responded to AVIATION WEEK's survey reported a total of $222 million in sales for 1958 and estimated their 1959 sales at $324 million.

Crystal ball estimates of sales for 1963 total $632 million, almost three times the 1958 figure and double the 1959 estimate.

Companies which participated in the survey include: AC Spark Plug, American Bosch Arma, Bell Aircraft, Ford Instrument, International Telephone & Telegraph, Kearfott, Litton Industries, Minneapolis-Honeywell, North American's Autonetics Division, Northrop's Nortronics Division and Sperry Gyroscope. The survey also discloses design aspects and trends in the bulk of systems now in production and many of those under development, as reported by manufacturers or gleaned from other sources.

Inertial system manufacturers were asked to provide the following data on their systems:

- **Type:** pure-inertial, stellar-inertial or Doppler-inertial.
- **Platform design:** three-gimbal, four-gimbal or no-gimbals.
- **Type of gyros:** single axis or dual axis; liquid-floated, air-bearings or other types of gyros.
- **Type of accelerometers:** non-integrating, single-integration or double-integration.
- **Type of computer:** analog, digital or combination of both.
- **System weight.**
- **System status:** in development, prototype or production.

Because accuracy is considered classified information, it was not requested of the manufacturers.

The bulk of current guidance systems are pure inertial, except for the Nortronics stellar-inertial system used in the Northrop Snark, the survey indicates. For ballistic missiles and large aircraft which normally are restricted in their maneuvers, a three-gimbal platform generally is used, the survey shows. On interceptor aircraft, however, systems being developed by Honeywell and Litton employ four-gimbal platforms to avoid the problem of gimbal-lock under 360-deg. pitch or roll maneuvers. An exception is the three-gimbal platform being used in the Kearfott system for the Lockheed F-104 and Convair F-106.

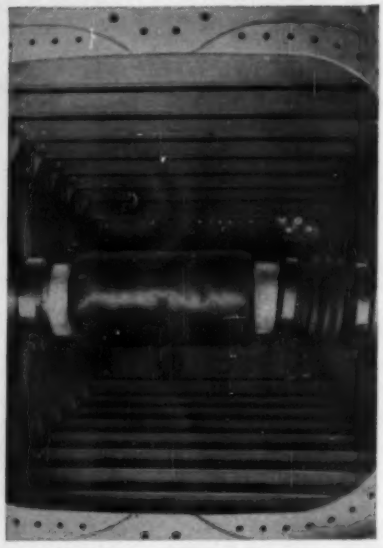
'Strapped-Down' Systems

New "strapped-down" inertial systems, which do not use stabilized platforms (no-gimbals), are being developed by International Telephone & Telegraph (ITT) and by Ford Instrument. This approach eliminates mechanical complexity and weight at the expense of a more sophisticated computer needed to perform the coordinate conversion required for accelerations sensed by

DC-8 uses newest G-E silicone rubbers

RTV compound used for caulking and sealing. RTV (room temperature vulcanizing) silicone rubber cures without the application of heat in any time you select up to 48 hours. It won't shrink (no solvents); forms no voids. RTV has excellent bond strength—plus resistance to high temperatures (above 600°F), moisture, weathering, ozone, aircraft fuels and solvents. Tough, elastic, good electrical properties.

SE-555 silicone rubber gaskets on door (above) and hatch. SE-555 has substantially double the strength of ordinary silicone rubbers. It combines maximum resistance to weather and temperature extremes (−150°F to 500°F) with the high tensile and tear strength previously found only in organic rubber. SE-555 meets AMS 3345 standards and can be fabricated in any color, including white.



Hot air duct of glass-cloth-reinforced Class 700 silicone rubber with flexible connectors of same material. (Ends sealed with General Electric RTV.) Ducts of G-E Class 700 silicone rubber have a service range from −120°F to 600°F and in other applications carry air up to 700°F. They resist common aircraft fuels and lubricants, have low compression set, and will not "cold flow" away from clamps.

For application data on G-E silicone rubbers, write General Electric Company, Silicone Products Dept., Section R7J4, Waterford, N. Y.

GENERAL ELECTRIC

Silicone Products Dept. **Waterford, N. Y.**

accelerometers attached to the vehicle. One system of this type being developed by ITT is expected to weigh 75 lb.; another is expected to weigh only 45 lb., the company says. Ford Instrument has given no details on its system.

In inertial system computers there appears to be a trend toward digital types, although analog computers predominate in current production, AVIATION WEEK's survey discloses.

A digital computer is mandatory for the strapped-down type inertial system because of the computational accuracy required.

The single-axis liquid-floated integrating gyro clearly dominates the inertial system field. However, Arma, Bell Aircraft and Litton Industries use the two-axis displacement type gyros and can present many arguments for their choice.

Ford Instrument employs single-axis air-bearing gyros, developed by Army Redstone Arsenal as an outgrowth of German gyro designs developed during World War II. North American also has done extensive work on gas-bearing gyros but does not disclose any details on its inertial systems.

In the area of accelerometers, the field is almost evenly divided between non-integrating and single-integration devices. Most systems using non-integrating accelerometers also employ digital computers which can perform the required integration function in addition to their other duties without significant increase in computer weight or complexity.

Smaller and More Accurate

A comparison of the weight of systems now in production with those under development today reveals the significant size-weight reduction that has been achieved in the past several years even though direct comparison is difficult unless system accuracies are known and comparable.

Inertial systems of a decade ago weighed 1,500 lb., occupied 50 cu. ft. of space, had an accuracy of around 5 naut. mi., and a mean-time-to-failure of only 50 hr., according to Frederick Stevens of Nortronics.

Today's inertial system weighs about 100 lb., occupies 3 cu. ft. space, has an accuracy of about one nautical mile and a mean-time-to-failure of about 2,000 hr., Stevens says.

An Air Force spokesman at Wright Air Development Center's Weapon Guidance Laboratory estimates that industry has achieved a 10:1 reduction in inertial system size and weight in the past several years. He predicts a significant, but not quite as large, reduction in the next several years. But by then further gains will be difficult

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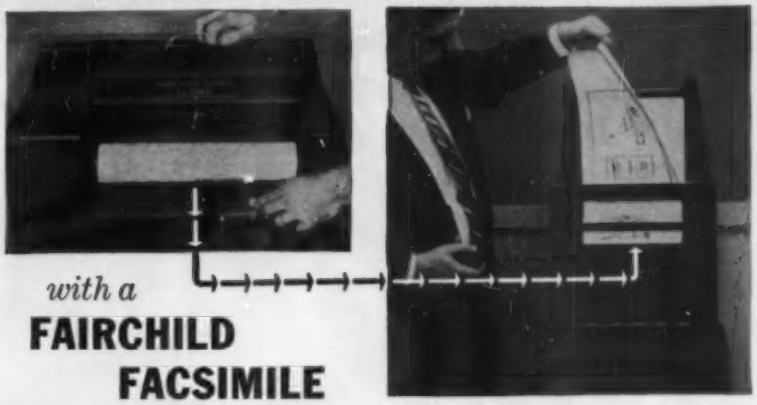

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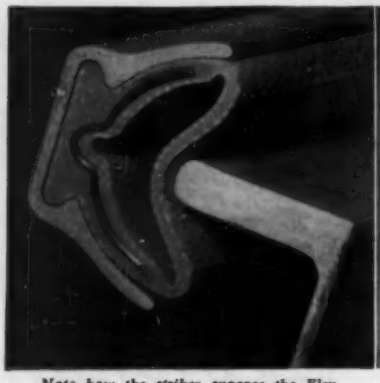
CONVAIR 880 DOOR SEAL

Fuselage entrance and service doors of the "880" airliner will be sealed under pressurized flight conditions by the Convair flex-support, self-energized, bulb-diaphragm seal manufactured by CHR. This new seal is constructed of high tear resistant silicone rubber, reinforced with dacron-fabric. An inner and outer pressure wall, a fail-safe feature, precludes loss of pressurization in the event of unforeseen damage to the outer pressure wall. The Convair flex-support is integrally molded within the seal to eliminate the possibility of collapse. This flexible spring steel wire supports the side walls of the seal when pressurized and assures positive alignment with the fuselage striker. This unique design, not found in conventional door seals, was necessitated by the unusual "880" plug type door structure.



Note how the striker engages the Flex-Support Seal. Tests prove you get a good seal at any angle of contact.

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to achieve unless major achievements are scored in developing fundamentally new types of gyros and accelerometers.

This is one reason why the Weapons Guidance Laboratory is sponsoring research in what it terms "exotic" inertial components. Current programs include investigation of the possibility of a nuclear-spin gyro at General Precision Laboratory, a crystal rate gyro at Gulton Industries, and another program at the W. L. Maxson Corp. Progress in the General Precision Laboratory program has been "most promising" to date, a spokesman says.

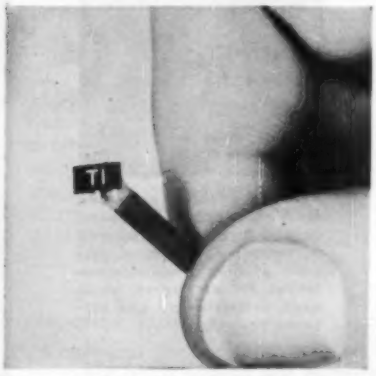
One of the most challenging problems for imaginative engineers and physicists is to come up also with fundamentally new approaches for sensing acceleration.

Study of the stabilization and acceleration sensing mechanisms which nature has designed for insects, in a volume smaller than the head of a pin, may provide insight into basically new approaches for miniaturizing inertial components and/or improving their accuracy. The vibrating gyro developed by Sperry Gyroscope Co. several years ago reportedly was inspired by the similar halteres (sensing organs) of the common housefly which are used to provide a form of gyro stabilization.

Future Guidance Systems

Inertial systems, in combination with automatic star/planet trackers, appear likely to play the dominant role in interplanetary space navigation. Here, however, the inertial system's primary role will be to provide spatial stabilization for the star/planet trackers to keep them approximately aligned on the body.

Several major inertial system producers already are developing stellar-inertial systems for such application.



Multivibrator

Microminiature multivibrator, fabricated entirely from a single silicon crystal, is one of several solid-state circuits produced by Texas Instruments (AW Mar. 30, p. 33) as part of its molecular electronics' program.

Klixon Precision Thermostats

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For dependable high-limit temperature control, the AiResearch Cabin Air Heater used in the Boeing 707 has several KLIXON M1 type snap-acting precision thermostats.

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For example, on the cabin air heaters produced by AiResearch Manufacturing Division of The Garrett Corporation, KLIXON Precision Thermostats assure positive temperature protection . . . contributing to heater safety and dependability. These heaters are lightweight units which fit into the 707's main cabin air-conditioning ducts where they warm incoming air to proper temperature. The thermostats shut off the main power source to the heaters as a safety precaution in the event temperature exceeds the limit value.

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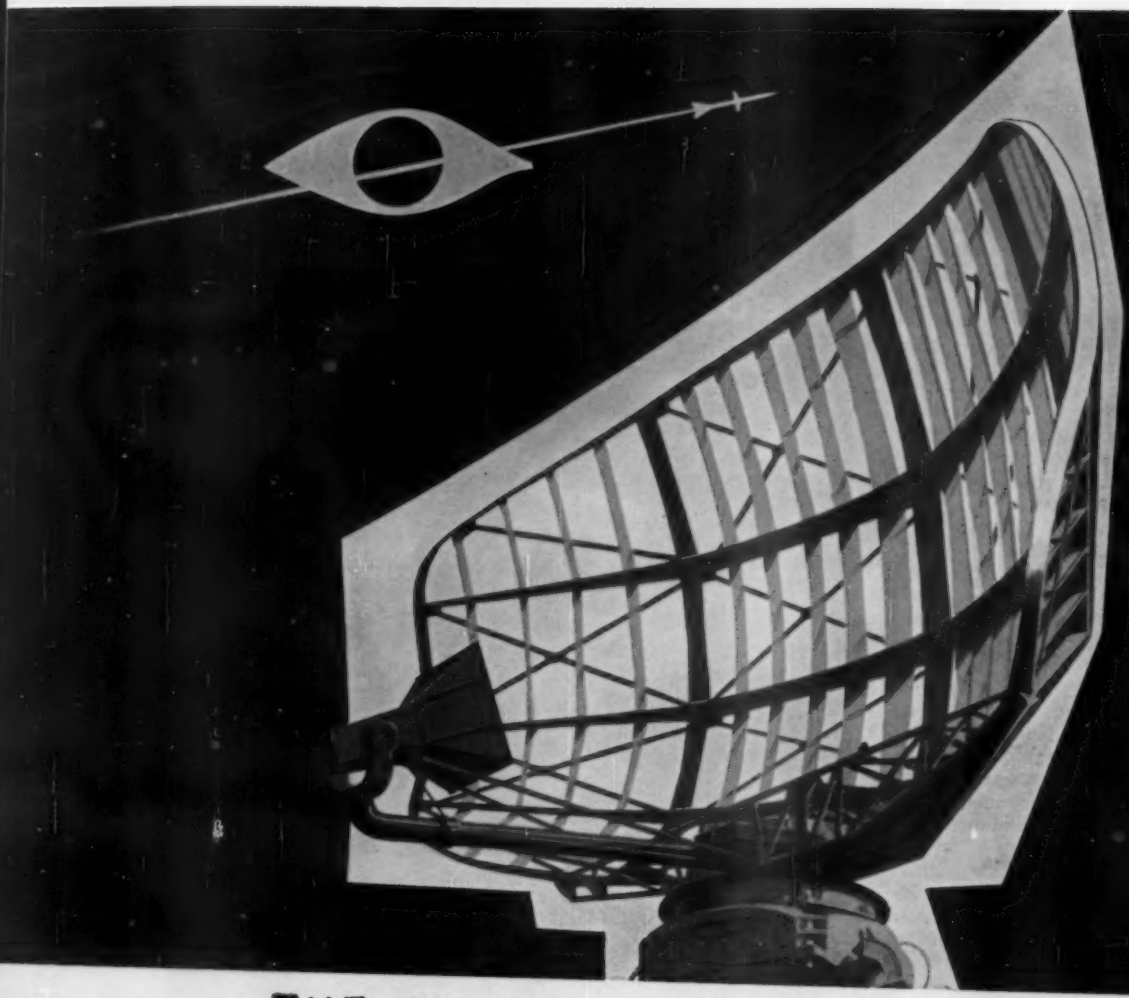

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Every new advancement in long-range detection finds Stavid in the vanguard, working with exotic as well as state-of-the-art techniques.

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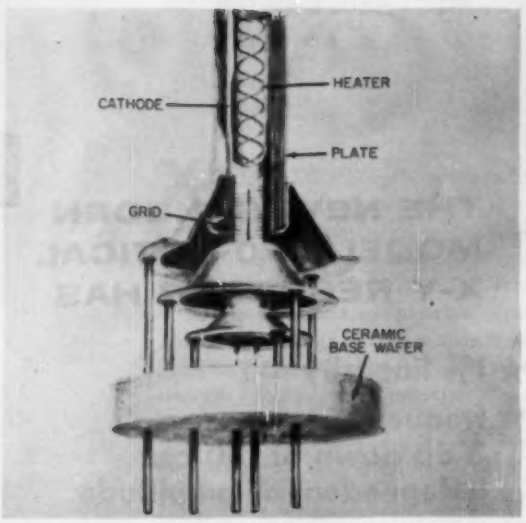
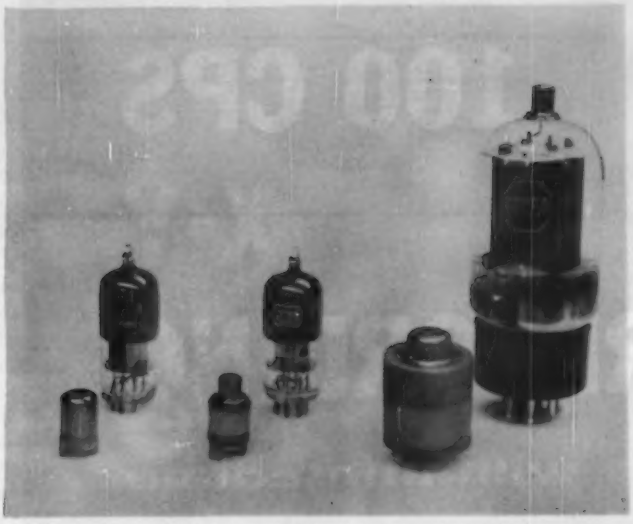




SCHEMATIC drawing showing Nuvistor construction is at left. Three types of Nuvistors that RCA is presently developing are compared at right with conventional miniature tubes: they are (left to right) a small signal triode, small signal tetrode, and beam power tube.

Tube Designed to Compete with Transistor

By James A. Fusca

New York—A new design concept for electron tubes may broaden the competition between tubes and semiconductor devices. The design approach is said to make possible tubes the size of thimbles that are more reliable and provide higher performance than conventional electron tubes.

Called Nuvistors, these new tubes are under development at the Radio Corp. of America's Electron Tube Division. At present, three different tube types are being readied for sample distribution within the next few months: a small signal triode, a small signal tetrode, and a beam power tube.

The design is the result of efforts by RCA tube engineers to limit the increasing encroachment of semiconductors in both the commercial and military receiving tube market. A further consideration was that sufficient reduction in size and power drain in a tube that could be mass produced, coupled with increased performance and reliability, could compete in areas where transistors have certain inherent disadvantages.

Development History

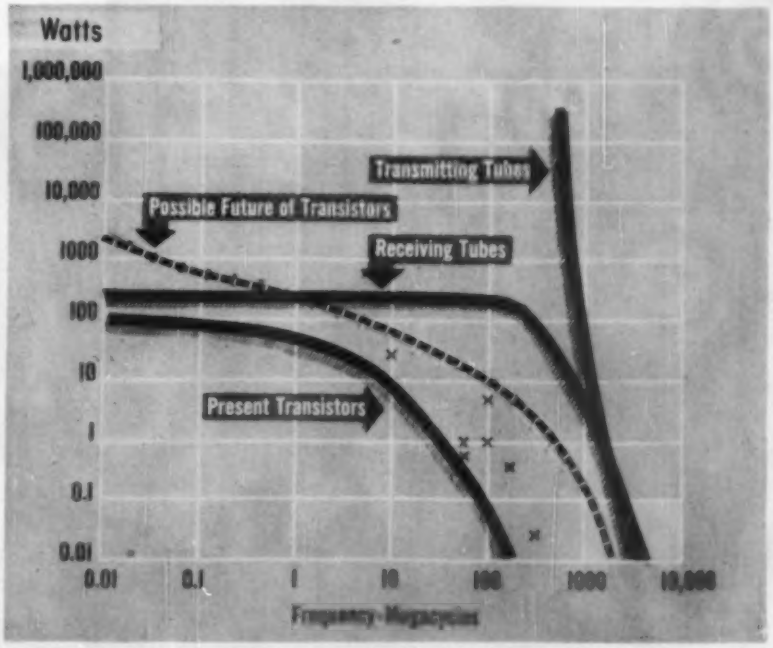
RCA engineers describe the Nuvistor concept as the result of a general study and development program seeking a new approach to electron tube design.

In the course of the program, planar structures, cylindrical structures, ceramic-spaced stacked structures, metal to glass seals, metal to ceramic seals, and similar areas were explored.

Planar tube elements, because of the apparent ease with which they could be assembled, was one area that was carefully investigated. It was found, however, that any advantage in assembly technique was offset by disadvantages in electrical and thermal characteristics.

The concept of cylindrical symmetary for receiving tube structures, however, gained increasing support. It offered electrical and thermal efficiency and stability, and could be manufactured easily and economically.

The design that resulted from this study employs concentric cylinders supported in an open-ended cantilever construction. These cylinders are held in place by tripod-like structures that are



POTENTIAL of electron tubes is compared with that of semiconductor devices in chart above. Small crosses represent performance of experimental transistors now being developed. RCA sees Nuvistor as extending area of competition between tubes and transistors.

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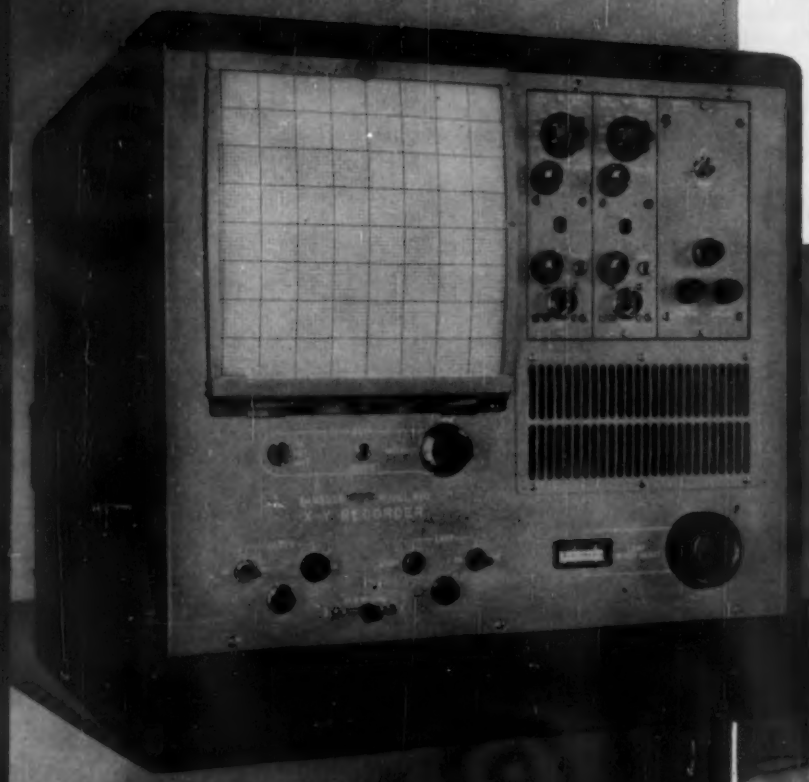

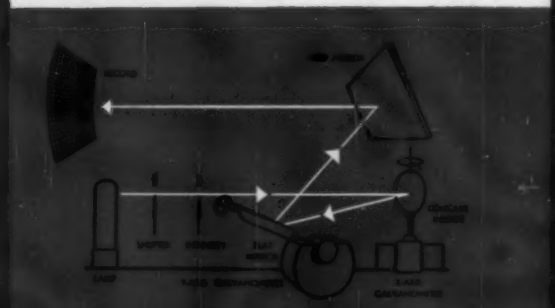

X-Y RECORDING never before possible with electromechanical instruments can now be done with the new Sanborn Model 670 X-Y Recorder. Direct writing on ultraviolet-sensitive recording paper by a beam deflected by optical galvanometers makes possible the combination of fast writing speed and 130 cps frequency response not found in any other X-Y recorder. Transistor characteristics, acceleration and vibration of mechanical parts and events of similar short duration can be recorded with linearity of *1% of full-scale* and at trace speeds as fast as *2500 inches per second.* Square wave response exhibits no greater than ½% overshoot *at any amplitude;* sensitivities as high as 62.5 uv/inch (depending on preamplifier used).

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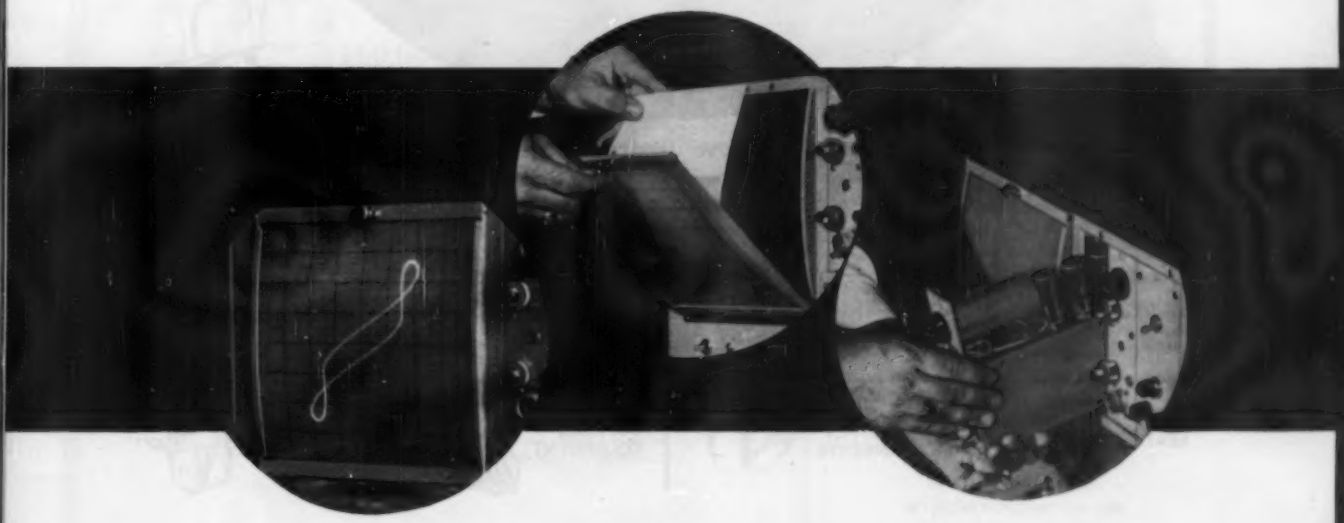
OPTIONAL INTERCHANGEABLE PREAMPLIFIERS for each axis presently include the Model 850-1300B DC Coupling and Model 850-1200 Phase Sensitive Demodulator; a Carrier Preamplifier, High Gain Preamplifier and a time base generator are now in development. Driver Amplifiers are compact, fully transistorized plug-in units with single-ended input and output. Galvanometers are low resistance, low voltage units of rugged, enclosed construction; sensitivity and damping are independent of coil temperature. Accessible, unitized circuitry also extends to the power supplies—a front-panel plug-in for both preamplifiers and a second supply for both driver amplifiers. A built-in blower provides constant, forced filtered air cooling. The Recorder can be rack mounted in 15¾" of panel space, or housed in its own 20" x 20" x 21¼" optional portable cabinet.



Ask your local Sanborn Sales-Engineering Representative for complete information on the Model 670 X-Y Recorder, or write the Industrial Division in Waltham, Mass.

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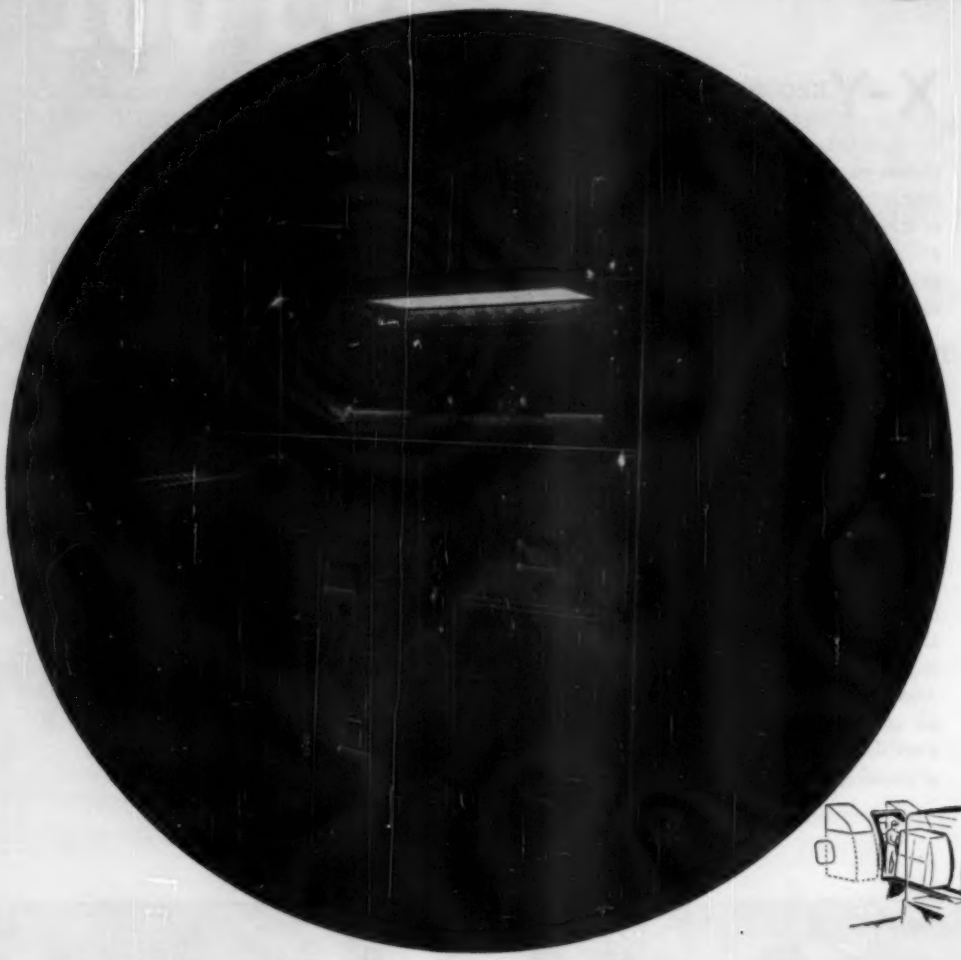

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TYPE	PCC88 (One unit frame grid)	6ES5 (Shielded grid)	NUVISTOR
Heater Power	1.05W	1.26W	0.85W
E_p	90V	200V	25V
E_c	−1.3V	−1V	−0.5V
I_p	15 ma	10 ma	7.5 ma
G_m	12,500 μmhos	9,000 μmhos	12,000 μmhos
Max. Plate Dissipation	1.6W	2.2W	1W
Capacitances:			
Input	3.3 μμf	3.6 μμf	4.5 μμf
Output	1.8 μμf	4.0 μμf	1.8 μμf
Grid-plate	1.4 μμf	0.4 μμf	2.8 μμf

OPERATING characteristics of Radio Corporation of America's Nuvistor are compared in table above with the characteristics of two more conventional triodes. Note Nuvistor plate voltage and plate dissipation.

mounted concentrically upon a ceramic base wafer.

Cantilever support for the electrodes eliminates the need for mica support disks or spacers. All joints in the complete tube assembly are brazed in a furnace at a temperature of about 2,000 F, and outgassed in a vacuum exhaust furnace.

The advantages claimed for this type of construction are:

• **Cylindrical symmetry** and cantilever support of the electrodes provide a combination of high cathode efficiency and permit the use of precision jigs for assembly.

• **Use of brazing** instead of spot welding for joining materials removes a potential source of failure and eliminates residual strain.

• **Mica supports** are not present to fray under vibration or interfere with high-temperature brazing and exhaust processing.

• **High-temperature degassing** removes many of the gases and impurities that are difficult to remove during manufacture of conventional tubes in which glass and mica limit the processing temperatures. It also allows operation of the tubes at higher temperatures.

• **Indexing lugs** on the base of the Nuvistors prevent damage to tube leads during insertion.

Design Considerations

When the electrode assemblies of an electron tube are scaled down proportionally, some characteristics do not change, some improve, and others become poorer. For example, cathode efficiency and high frequency performance both improve. General operating characteristics such as mutual conductance and plate resistance remain substantially the same.

Cathode current density, however, increases and the grid and plate operate at much higher temperatures. These latter effects tend to reduce tube life and reliability. Both of these effects can be offset if the electrode spacings are scaled down by a greater amount

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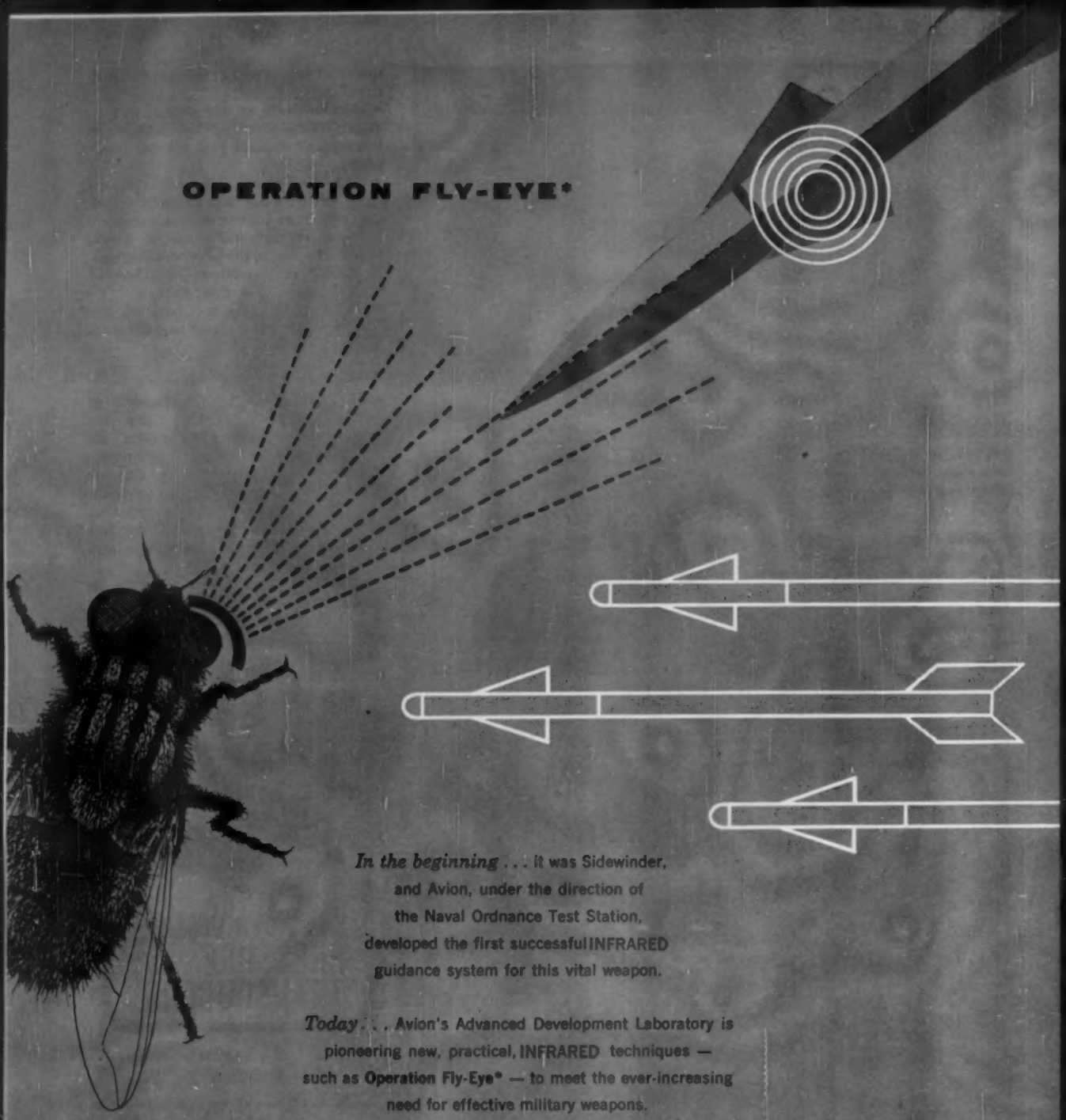

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400mc	21W	130V	250ma	65%
400mc	100W	500V	250ma	80%
400mc	175W	1000V	200ma	87%

CHARACTERISTICS and efficiency of Nuvistor and transistor are compared above.

TYPE	6CY5 (tetrode)	NUVISTOR (tetrode)
Heater Power	1.44W	0.85W
E_p	125V	60V
E_{c2}	80V	30V
E_{c1}	−1.V	−0.5V*
I_p	10ma	5ma
I_{c2}	1.5ma	1.7ma
G_m	8,000 umho	9,000 umho
r_p	100,000 ohm	200,000 ohm
Max. Plate Dissipation	1.7W	3.W
Capacitances:		
Input	4.5 uuf	6.5 uuf
Output	3.0 uuf	1.4 uuf
Grid-plate	0.03 uuf	0.01 uuf

*Grid leak bias—1 megohm

CHARACTERISTICS of Nuvistor tetrode are compared with conventional tetrode.

than the other dimensions and if more efficient thermal paths are provided for removing excess heat.

This differential scaling makes possible the use of much lower electrode voltages, thereby providing several advantages in addition to the corresponding reduction in power input. A major advantage of reduced voltage is a substantial improvement in cathode life because less energy is imparted to residual gases which might damage the cathode through ion bombardment. Another advantage is the reduced insulation required in the tube, tube socket, and associated circuit elements.

Thermal Paths

Thermal paths in tubes are important. In the case of the cathode and its supporting structure, heat conservation is the major consideration. For maximum cathode efficiency, low thermal conductivity and low thermal emissivity are needed. The grid and the plate, however, require paths of high thermal conductivity so that the grid stays cool enough to avoid grid emission and so that the plate operates at a low enough temperature so that gas evolution is minimized.

The effects of scaling down electrode spacing can be seen in the tube characteristics of the Nuvistors, and the results of providing paths of high thermal conductivity in the power dissipation capabilities.

	6DQ5	NUVISTOR BEAM POWER TUBE
Heater Pwr.	15.5W	5W
Minimum Plate Volt.	40V	30V
Screen Grid E_{c2}	125V	65V
Maximum Current I_p (0-bias)	520ma	660ma
I_p (−10v bias)		200ma
Plate Dissipation Capability	24W	30W

NUVISTOR beam power tube is compared with conventional tube above.

Engineers of RCA's Electron Tube Division consider the advantages of electron tubes when compared with semiconductor devices places the Nuvistor in a favorable position. Some of the advantages claimed are:

- **Electrode spacing** in an electron tube can be 50 times larger than the electrode spacing in a transistor intended for comparable performance. Consequently, tube spacings and the associated tolerances can be more easily controlled in manufacturing operations.
- **Electron tubes are economical** in initial cost, have high impedance and gain, and generally require less expensive associated circuit components.
- **Noise factor and gain** of a tube are superior at high frequencies.
- **Electron tubes have** a high uniformity of initial characteristics and do not require a costly selection process.
- **Electron tubes are capable** of handling momentary overloads and are less susceptible to radiation damage.
- **Electron tubes maintain** their characteristics over a wide range of ambient temperatures.

Because of the cylindrical construction of the Nuvistors, RCA expects to be able to produce the tubes in large quantities and with a highly automatic assembly. The tube elements are dropped into place concentrically and held to the proper spacing by precision cylindrical jigs until brazed. The use of a cathode support sleeve to secure the active cathode makes it possible to braze the supporting structure before insertion of the cathode itself which would be damaged by heat.

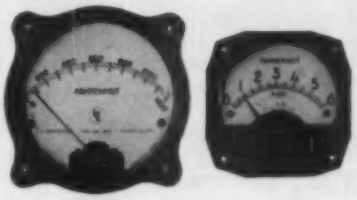
One other company that is known to be working toward development of a similar type of very small, highly efficient electron tube is General Electric. Both companies are exploring the possibilities offered by combining this type of construction with the cold cathode operation being studied by Tung-Sol.

LEWIS
Indicating Pyrometers

for temperature testing in the laboratory or in the plane...

Constructed with the same care as our aircraft temperature indicators, these pyrometers bring "aircraft quality" to the test engineer.

MODEL 58PY, above, has been used extensively by leading motor car manufacturers for road testing on the "Proving Grounds" — where performance counts. Housed in rectangular bakelite case, has 6" hand drawn scale and is fully compensated for ambient temperature. Made in ranges listed below, with suitable thermocouple materials.



MODEL 23B, left above, has same type movement as our aircraft pyrometers. Housed in flanged, 4" round, bakelite case for panel mounting.

MODEL 20B, right above, has same 3" steel case and same movement as our aircraft panel indicators. Both are fully cold-end compensated and available in standard ranges listed, with suitable thermocouple materials.

STANDARD RANGES—All Models
FAHRENHEIT
Zero to 400, 600, 800, 1000, 1200, 1600, 1800, 2000 and 2500.
CENTIGRADE
Zero to 200, 300, 400,. 500, 600, 800, 1000, 1100 and 1400.

Furnished with white scales, black markings and pointer or, with black scales white markings and pointer if specified. For best results use LEWIS Thermocouples, Leads and Selector Switches with these instruments.

THE LEWIS ENGINEERING CO.
Manufacturers of Complete Temperature Measuring Systems for Aircraft
NAUGATUCK, CONNECTICUT

MISSILE TRACKING

SEA-LAB

This huge antenna is part of an electronic and optical system that RCA installed and is operating on the S.S. American Mariner. The purpose of the equipment, for which the ship has been refitted, is to provide the most precise data yet obtained at sea on missile flights over a range extending from Cape Canaveral, Fla., to the area of Ascension Island. The project is sponsored jointly by the Advanced Research Projects Agency, Department of Defense and the Army Ordnance Command. A scientific staff—most of them RCA personnel—will operate the equipment and report on missile performance from descent from space to final plunge, the data to be shared by all branches of the armed services.

RCA Trk(s) ®

RADIO CORPORATION of AMERICA

DEFENSE ELECTRONIC PRODUCTS
CAMDEN, N. J.

FILTER CENTER

▶ **Minimizing Radome Distortion**—New technique which partially compensates for radome distortion of radar line-of-sight in missile guidance systems has been developed by Ohio State University's Electrical Engineering Department. Technique bears some similarity to self-adapting techniques now being developed for automatic flight control systems (AW Feb. 9, p. 89.) Program, headed by Prof. Robert Cosgriff, is sponsored by Wright Air Development Center's Weapons Guidance Laboratory.

▶ **National Telemetry Symposium**—Call for prospective authors of technical papers has gone out for National Symposium on Telemetering to be held in San Francisco, Sept. 28-30. Papers are solicited on space vehicle communications, satellite instrumentation, data processing and new telemetry developments. A 100-200 word abstract and a 500-word summary should be sent, prior to May 10, to George L. Larse, Lockheed Missile Systems Division, Sunnyvale, Calif.

▶ **Field Emission Cathode Ray Tube**—Feasibility of using a field emission cathode as an electron source for a cathode ray tube has been confirmed by study conducted by Linfield Research Institute under Wright Air Development Center sponsorship. Report on research program, identified PB 151246, can be obtained from Office of Technical Services, Dept. of Commerce, Washington 25, D. C., for $1.00

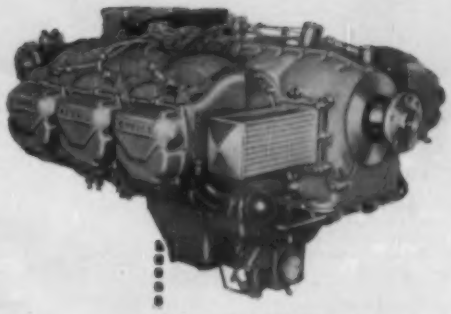
▶ **Signed On Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Tele-Dynamics, Inc.,** Philadelphia, will design a new high-speed system for rapid transmission of weather charts under contract awarded by Air Force Cambridge Research Center. New system, called "Televelofax," will be able to transmit 10 times as many charts as present over same facilities in given time, the company says.

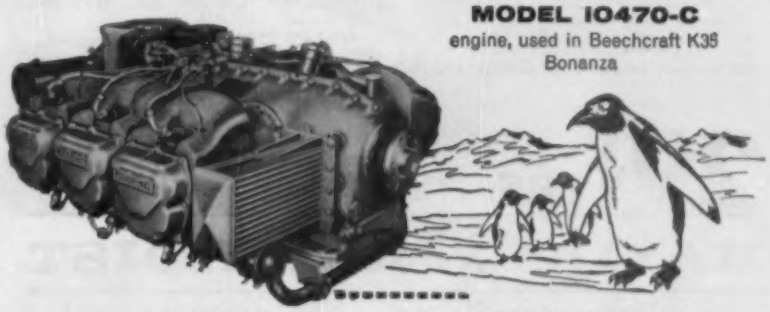
• **The W. L. Maxson Co.,** New York, $288,000 contract from Bell Helicopter Corp., for development of helicopter landing system, known as HELP (Helicopter Electronic Landing Path) for use in all-weather conditions.

• **General Electric Defense Systems Dept.,** Syracuse, N. Y., three contracts totaling $110 million, for ground-based guidance system for Atlas, from Air Materiel Command's Ballistic Missiles Center. Contracts cover work carried out under previous letter contracts.

There's NO ICING



MODEL IO470-C
engine, used in Beechcraft K35 Bonanza



WITH CONTINENTAL Continuous Flow FUEL INJECTION

MODEL IO470-D
engine, used in Cessna 310-C twin engine executive aircraft

The engine icing hazard inseparable from carburetor type aircraft engines vanishes when you fly with Continental Fuel Injection, for the refrigerating effect of vaporizing fuel at the carburetor is ended by eliminating the carburetor itself. With Continental Fuel Injection, no carburetor heat is ever required. You always use the coldest available air, for maximum power.

Add this gain in safety to the new system's other advantages:

. . . and you understand why this exclusive system is acclaimed as the greatest flying advance in recent years —why it is featured today in the finest utility aircraft in the world.

SMOOTHER OPERATION
GREATER ECONOMY
HIGHER HORSEPOWER
FASTER ACCELERATION
REDUCED MAINTENANCE

Continental Motors Corporation
AIRCRAFT ENGINE DIVISION
MUSKEGON • MICHIGAN

Petroleum Contracts

Following is a list of unclassified contracts for $25,000 and over as released by the Military Petroleum Supply Agency in Washington, D. C.:

Cities Service Oil Co., New York, jet fuel #4, 4,814,000 gal., (IFB-59-75), $442,888.

The Consumers Cooperative Assn., Kansas City, Mo., jet fuel #4, (IFB-59-75), 14 million gal., $1,282,400.

Triangle Refineries, Inc., Houston, Tex., jet fuel #4, 25,900,000 gal., (IFB-59-75), $2,485,923.

The Texas Co., New York, jet fuel #4, 7,564,000 gal., (IFB-59-75), $732,186.

Champlin Oil & Refining Co., Fort Worth, Tex., jet fuel #4, 12 million gal., (IFB-59-75), $1,150,800.

El Paso Natural Gas Products Co., El Paso, Tex., jet fuel #4, 12,800,000 gal., (IFB-59-7-), $1,340,160.

The Shamrock Oil & Gas Corp., Amarillo, Tex., jet fuel #4, 31 million gal., (IFB-59-75), $3,042,120.

Seaside Oil Co., Santa Barbara, Calif., jet fuel #4, 7,320,000 gal., (IFB-59-75), $766,-580.

Esso Standard Oil Co., New York, jet fuel #4, 152,136,400 gal., (IFB-59-75), $13,-652,295.

General Petroleum Corp., Los Angeles, Calif., jet fuel #4, 10,500,000 gal., (IFB-59-75), $950,972.

Leonard Refineries, Inc., Alma, Mich., jet fuel #4, 33 million gal., (IFB-59-75), (set aside), $377,520.

Howell Refining Co., San Antonio, Tex., jet fuel #4, 4,117,000 gal., (IFB-59-75), (set aside), $416,023.

Jet Fuel Refinery Co., Billings, Mont., jet fuel #4, 80,000 gal., (IFB-59-75), (set aside), $91,960.

Danube Refining Co., Houston, Tex., jet fuel #4, 9,800,000 gal., (IFB-59-75), (set aside), $990,290.

Advance Refining Co., Centralia, Ill., jet fuel #4, 3,022,000 gal., (IFB-59-75), (set aside), $321,239.

Northwestern Refining Co., St. Paul Park, Minn., jet fuel #4, 5,775,000 gal., (IFB-59-75), (set aside), $677,633.

Sioux Oil Co., New Castle, Wyo., jet fuel #4, 13 million gal., (IFB-59-75), (set aside), $1,621,100.

Berry Asphalt Co., Magnolia, Ark., jet fuel #4, 1,800,000 gal., (IFB-59-75), (set aside), $184,536.

Laketon Asphalt Refining Co., Evansville, Ind., jet fuel #4, 5 million gal., (IFB-59-75), (set aside), $573,000.

Western States Refining Co., North Salt Lake, Utah, jet fuel, #4, 3 million gal., (IFB-59-75), (set aside), $381,570.

Petroleum Trading & Transport Co., Tulsa, Okla., jet fuel #4, 8,233,000 gal., (IFB-59-75), (set aside), $837,325.

The Vickers Petroleum Co, Inc., Wichita, Kans., jet fuel #4, 10 million gal., (IFB-59-75), (set aside), $944,200.

Delta Refining Co., Yazoo, Miss., jet fuel #4, 13 million gal., (IFB-59-75), (set aside), $1,360,053.

Vulcan Asphalt Refining Co., Cordova, Ala., jet fuel #5, 1,100,000 gal., (IFB-59-76), $107,109.

Union Oil Co. of California, Los Angeles, Calif., jet fuel #5, 11,970,000 gal., (IFB-59-76), $1,159,893.

Shell Caribbean Petroleum Co., New York, jet fuel #5, 5,040,000 gal., (IFB-59-76), $489,384.

Tidewater Oil Co., Los Angeles, Calif., jet fuel #5, 1,914,000 gal., (IFB-59-76), $188,415.

Esso Standard Oil Co., New York, N. Y., jet fuel #5, 28,260,000 gal., (IFB-59-76), $2,455,794.

Sinclair Refining Co., New York, jet fuel #4, 58,585,000 gal., (IFB-59-75), $5,210,423.

Cosden Petroleum Corp., Big Spring Tex., jet fuel #4, 37,500,000 gal., (IFB-59-75), $3,933,700.

Derbey Refining Co., Wichita, Kans., jet fuel #4, 15 million gal., (IFB-59-75), $1,423,547.

General Asphalts, Inc., Oklahoma City, Okla, jet fuel #4, 14 million gal., (IFB-59-75), $1,288,000.

Leonard Refineries, Inc., Alma, Mich., jet fuel #4, 7 million gal., (IFB-59-75), $818,300.

Suntide Refining Co., Corpus Christi, Tex., jet fuel #4, 5 million gal., (IFB-59-75), $450,000.

Malco Refineries, Inc., Roswell, N. M., jet fuel #4, 32,500,000 gal., (IFB-59-75), $3,363,750.

Utah Oil Refining Co., Salt Lake City, Utah, jet fuel #4, 9,350,000 gal., (IFB-59-75), $1,232,365.

Wilshire Oil Co. of California, Los Angeles, Calif., jet fuel #4, 21 million gal., (IFB-59-75), $1,774,500.

The Standard Oil Co. (Ohio), Cleveland, Ohio, jet fuel #4, 42,400,000 gal. (IFB-59-75), $4,361,790.

Premier Oil Refining Co. of Texas Division, City Products Corp., Longview, Tex., jet fuel #4, 10,500,000 gal., (IFB-59-75), $1,055,100.

Ashland Oil & Refining Co., Ashland, Ky., jet fuel #4, 35,067,000 gal., (IFB-59-75), $3,721,383.

Cardinal Transports, Inc., San Antonio, Tex., jet fuel #4, 2 million gal., (IFB-59-75), $199,600.

Standard Oil Co. (Indiana), Chicago, Ill., jet fuel #4, 31,825,000 gal., (IFB-59-75), $3,029,578.

Socony Mobil Oil Co., Inc., New York, jet fuel #4, 20,160,000 gal., (IFB-59-75), $2,122,848.

Humble Oil & Refining Co., Houston, Tex., jet fuel #4, 37,600,000 gal., (IFB-59-75), $3,589,100.

Republic Oil Refining Co. Division, Plymouth Oil Co., Pittsburgh, Pa., jet fuel #4, 7,154,000 gal., (IFB-59-75), $656,737.

The Pure Oil Co., Chicago, Ill., jet fuel #4, 55,880,000 gal. (IFB-59-75), $5,548,928.

Union Oil Co. of California, Los Angeles, Calif., jet fuel #4, 85,260,000 gal., and jet fuel #3, 4,574,000 gal., (IFB-59-75), $7,605,144

29½ LBS. of Big LIFT!

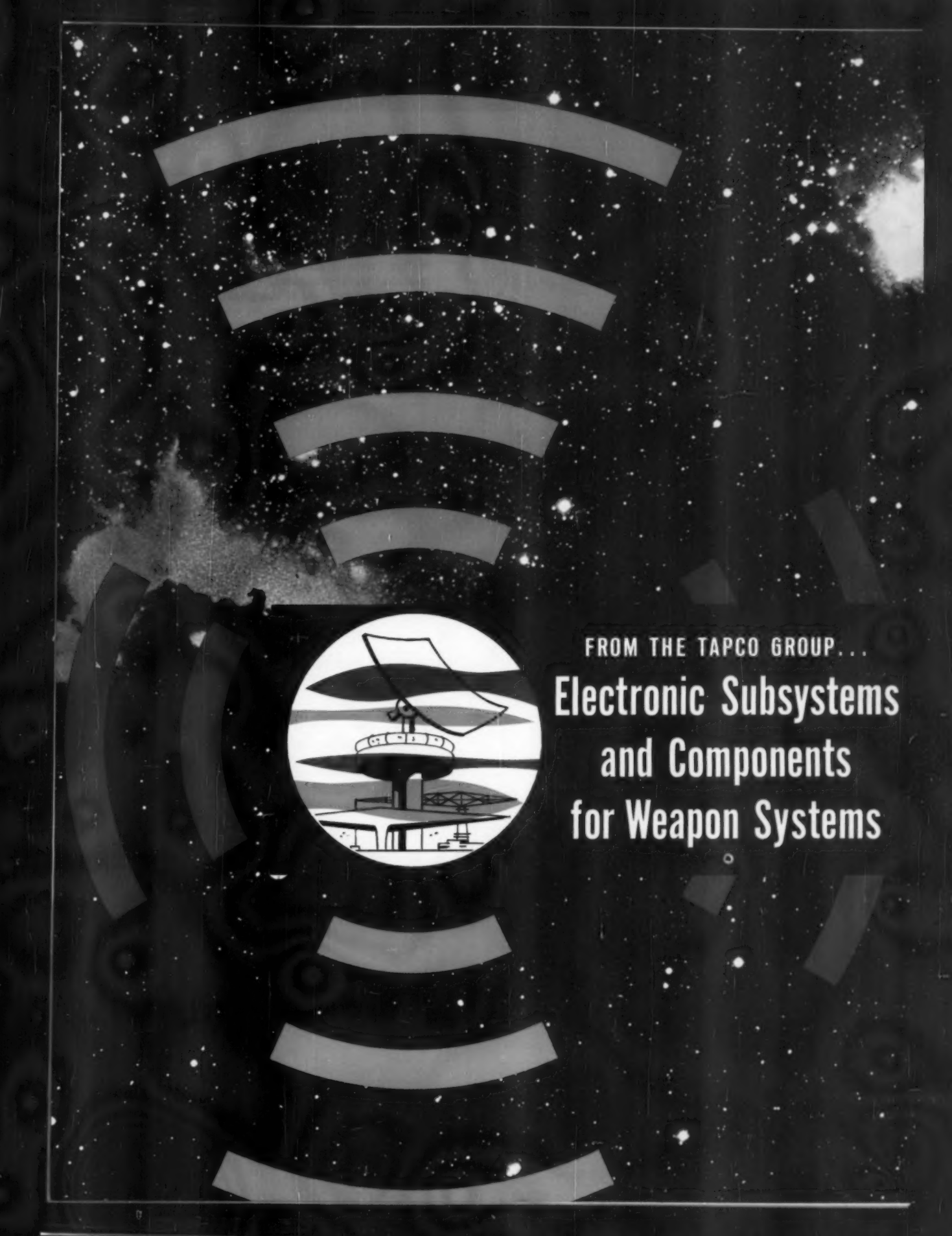
HAYDU RESCUE HOIST

- Pint size 29½ lb. Rescue Hoist — can lift 600 lbs. with ease!
- Universally adaptable — equipped with hydraulic motor, AC motor, or DC motor.
- Rugged, durable hoist has anti-fouling level-wind mechanism, guillotine cable cutter, rubber rollers, up-and-down limit switches.
- Equipped with 100 ft. of usable non-twist stainless steel cable.
- Built-in provision for communication between 'copter and rescue party.
- Rated speed — 100 fpm.
- Hoist is aluminum construction and has numerous cargo applications!

HAYDU Industries CORPORATION

AIRCRAFT ACCESSORIES DIVISION

PLAINFIELD, NEW JERSEY

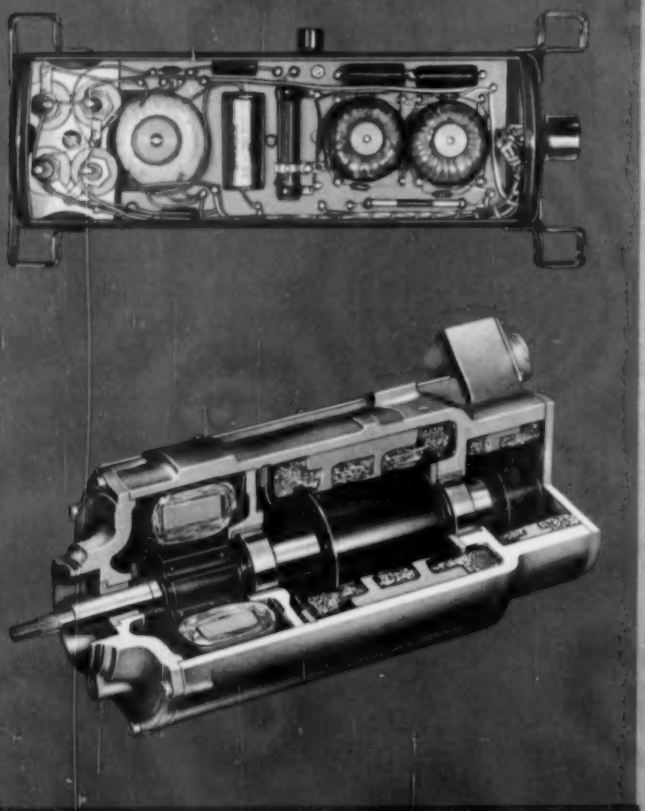

FROM THE TAPCO GROUP...
Electronic Subsystems
and Components
for Weapon Systems

AT TAPCO...

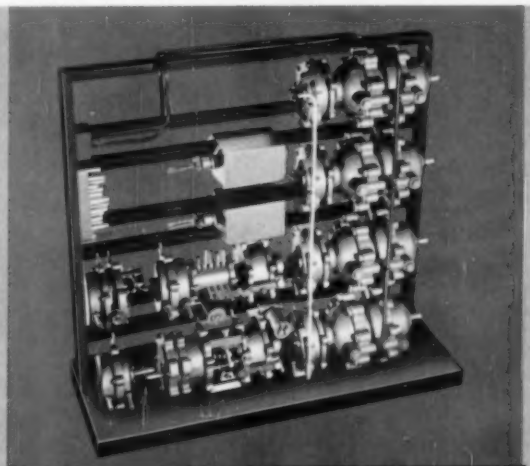
A unique combination of electronic, electrical and mechanical skills

Your project may require microwave subsystems and components. Or a complete ground support check-out device. Or servo-controlled subsystems and components for a whole new vehicle concept. On each of these the TAPCO Group can design, develop, and manufacture your requirements on schedule.

The TAPCO Group is experienced in the design and manufacture of electronic controls, including closed-loop servo systems and components, positioning controls, and small power-system alternators. Experience with microwave components includes coaxial and wave guide switches, power dividers, stripline microwave



APU tuned circuit speed control and alternator TAPCO designed and produced for 2400/400-cycle surface-to-air missile power. Alternator uses new-type permanent magnets that are fully short-circuit stable. Also incorporates unique flux-switching generator for speed control.



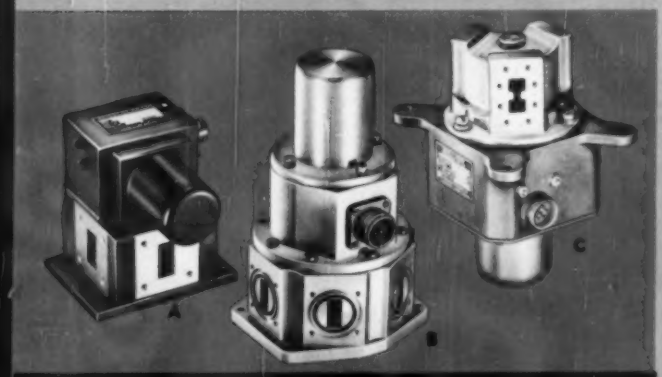
AICS, a high temperature (600°F) pneumatic computing control system, designed for air-induction inlet control or thrust reverser control for jet aircraft.

Precision position and speed servos in this TAPCO-developed ground support unit perform programmed check-out of missile guidance equipment. Readily adaptable to advanced antenna positioning and tracking systems.

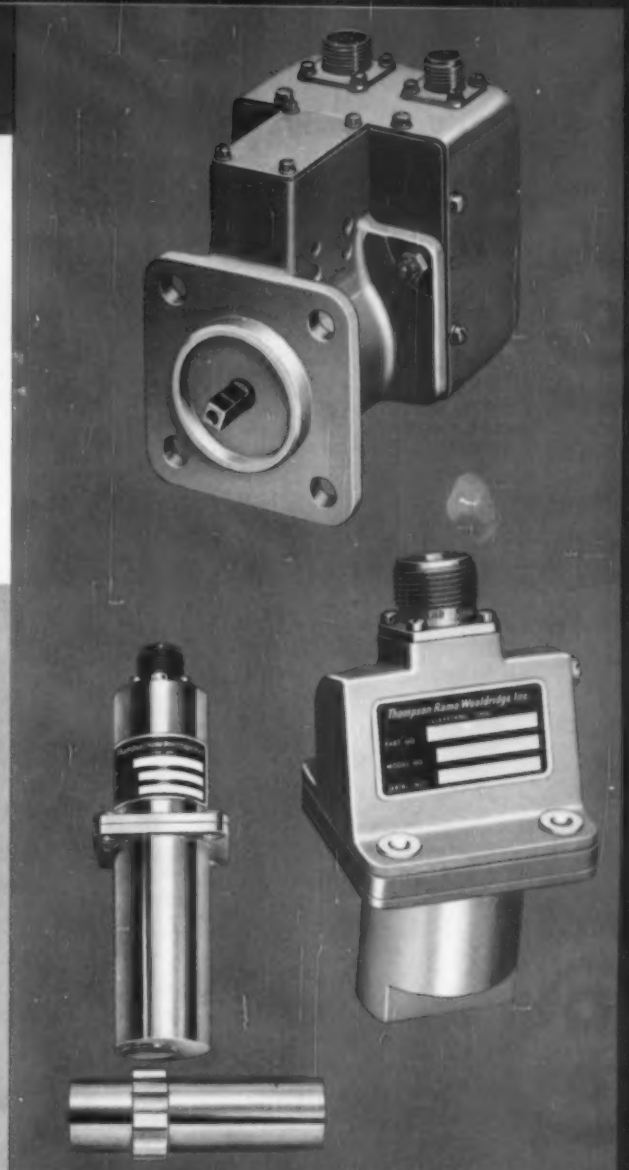
filters, and microwave antennas.

Air-vehicle electronic systems developed by the TAPCO Group include highly sensitive electro-pneumatic controls capable of maintaining the speed of rotating electrical machines within plus-or-minus ¼ % in either parallel or isolated operation under widely varying loads, ambient temperatures, and vibration. TAPCO-developed APU speed controls provide an accuracy of one part in 100,000 (.001%) under missile environmental conditions.

At TAPCO you'll find an unusual combination of electronic, electrical and mechanical skills ready to serve you.



Thousands of TAPCO-developed wave guide switches are used in vital aircraft and missile systems. (a) Unique power-splitting feature of rectangular wave guide switch permits switching full wave-guide power. (b) New single-pole 4-throw design has inter-channel attenuation in excess of 100 db. (c) Double-ridged wave guide switch has noise-free interlocking actuator.



Magnetic speed sensing devices developed and produced by TAPCO Group for high-speed applications up to 100,000 rpm. Designs eliminate need for slip-rings, rotating permanent magnets, and complicated fly-ball mechanisms.

An advanced TRW microwave antenna design available in integrated microwave transmission subsystems from the TAPCO Group. Frequency range: 1 octave. VSWR: under 2:1. Polarization: dual horizontal and vertical.

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

CLEVELAND 17, OHIO

DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC AND NUCLEAR INDUSTRIES

Primary Standards Laboratory at TAPCO, where all secondary test equipment is calibrated at statistically-determined intervals to assure the accuracy of electronic products.

Electronics Research and Production Facilities at TAPCO

The combination of engineering and manufacturing competence represented in the $160,000,000-per-year activities of the TAPCO Group provides an integrated capability of unusual effectiveness for the design and manufacture of electronic products. In addition, the electronic facilities and competence of the corporation's RAMO-WOOLDRIDGE Division are available to the TAPCO Group.

Our scientists and engineers can move rapidly on simultaneously-programmed projects. Analog and digital computers speed the design of electronic systems, then simulate their operation for test purposes. Components, electronic systems and subsystems designed in the TAPCO Group are produced within the Group.

Let us show you how we can design, develop, and manufacture electronic subsystems and components to meet your performance, reliability, and delivery requirements.

Production testing of microwave components at TAPCO.

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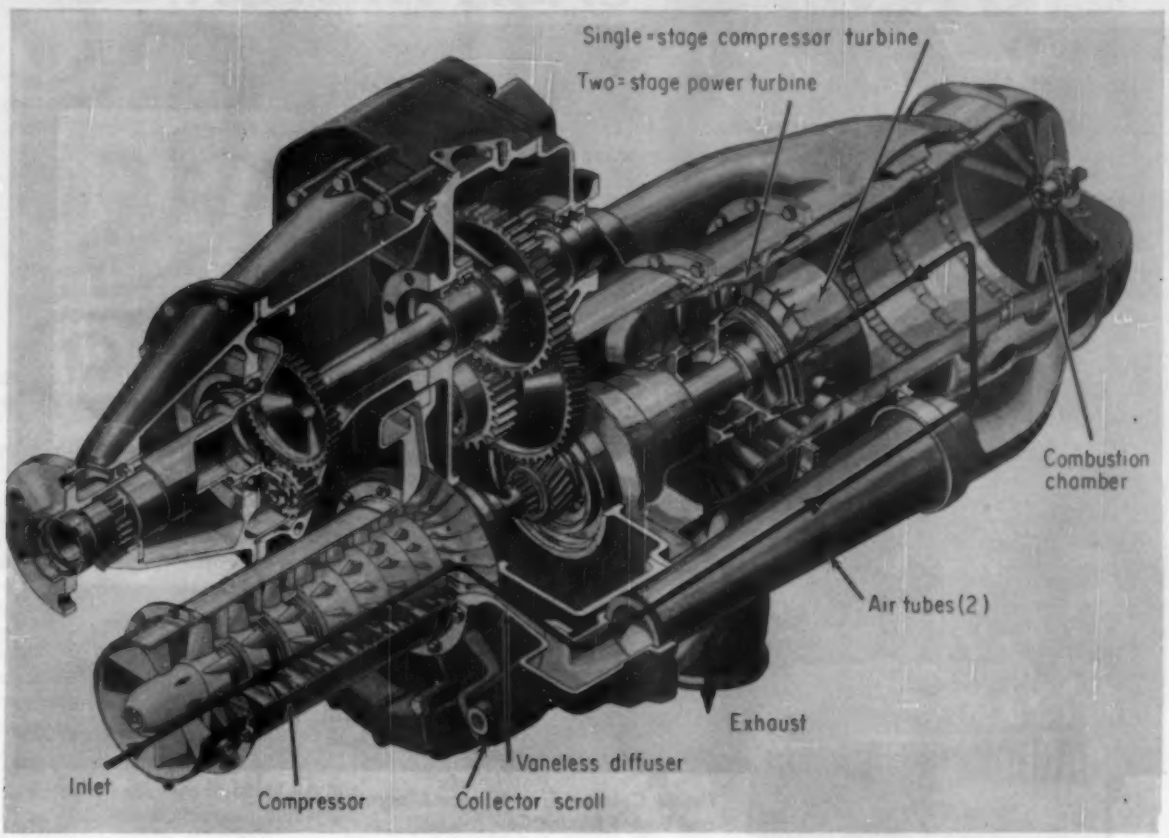
DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC AND NUCLEAR INDUSTRIES



PRIMARY STRUCTURE of T63 is gear box onto which power-producing elements, accessories and reduction gearing are bolted. Airflow angles outward from compressor, passes through external tubes on sides of engine and then is angled into single combustion chamber.

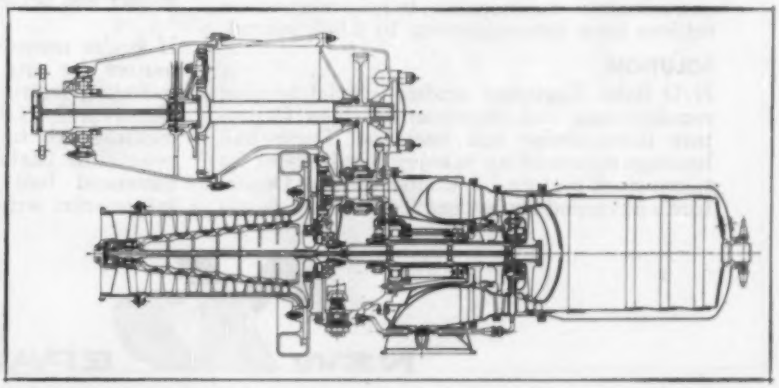
T63 Designed for Low Cost Production

By Erwin J. Bulban

Conservative design approach is being combined with advanced manufacturing methods by engineers of Allison Division of General Motors Corp. in its new 250-shp. T63 series of gas turbine powerplants. Aim is to achieve low cost, light weight, simplicity and reliability.

Allison officially refuses to discuss probable prices for publication—the company will only say that it expects to sell the T63 competitively with piston engines of similar powers—but industry sources estimate that the new engine will sell for somewhere between $15-$20 per horsepower, in production quantities.

These same sources also say that an important factor in the cost aspects of the engine will be Allison's use of plastics for major assemblies of the engine, including the compressor section. These probably will not show up in prototype models, but will be worked in during later phases of the engine's development. One clue seen is in current makeup of the compressor section. The seven axial stages now are one-piece castings, stacked to form a complete assembly, rather than conventional build-up of a separate disk or disks and blades. These current metal castings are expected to be translated to plastics



DOWNWARD EXHAUST in center of engine is clearly shown in cross-section. This is YT63-A-1 prop-drive version, which reduces 6,000 shaft rpm. to 2,000 rpm. at propeller.

CASE HISTORIES

Frequency Time Standard instruments, selected by Smithsonian Institute to clock satellites, are equipped with New Departure ultra-precise ball bearings.

Photos: Courtesy Ernst Norman Laboratories and Bodine Electric Co.

Ultra Precise Ball Bearings Help "Clock" A Satellite!

CUSTOMER PROBLEM:

Require ultra-precise bearing design for Bodine electric motor used in satellite-tracking micro-clock. Bearings must provide uniformly low starting torque, precise location of rotor shaft and minimum maintenance, to help mechanism achieve time determinations to 0.001 second.

SOLUTION:

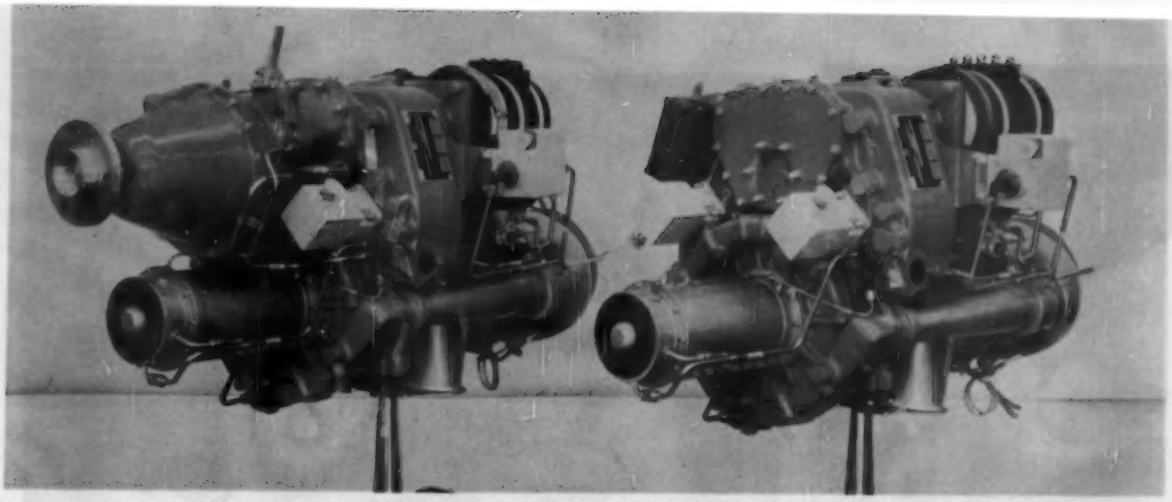
N/D Sales Engineers studied special bearing requirements, and recommended New Departure ultra-precise ball bearings. These ball bearings measured up to every requirement for micro-clock motors . . . thanks to New Departure's advanced equipment for research, development and production. N/D equipped micro-clocks, selected by the Smithsonian Institute, are operating in a dozen locations around the world right now, keeping track of vital satellite movements . . . to accuracies of one millisecond and better!

If you're manufacturing or designing electric motors for any high precision applications, including instruments, why not call on New Departure? N/D engineering and research facilities are turning out the latest in high precision instrument ball bearings and advanced ball bearing designs. For more information write Department G-4.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL



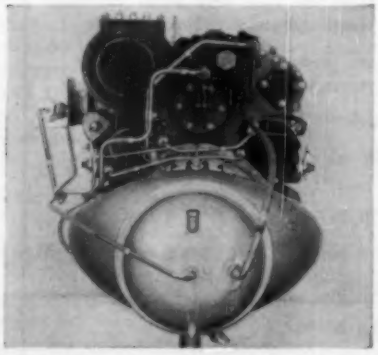
DESIGN PROBLEM in T63 was developing best arrangement of gear sections and accessories, which bulk disproportionately large compared to power-producing elements. Shown are full-scale mockups of propeller-drive YT63-A-1 (left) and shaft-drive YT63-A-3.

application in the later phases.

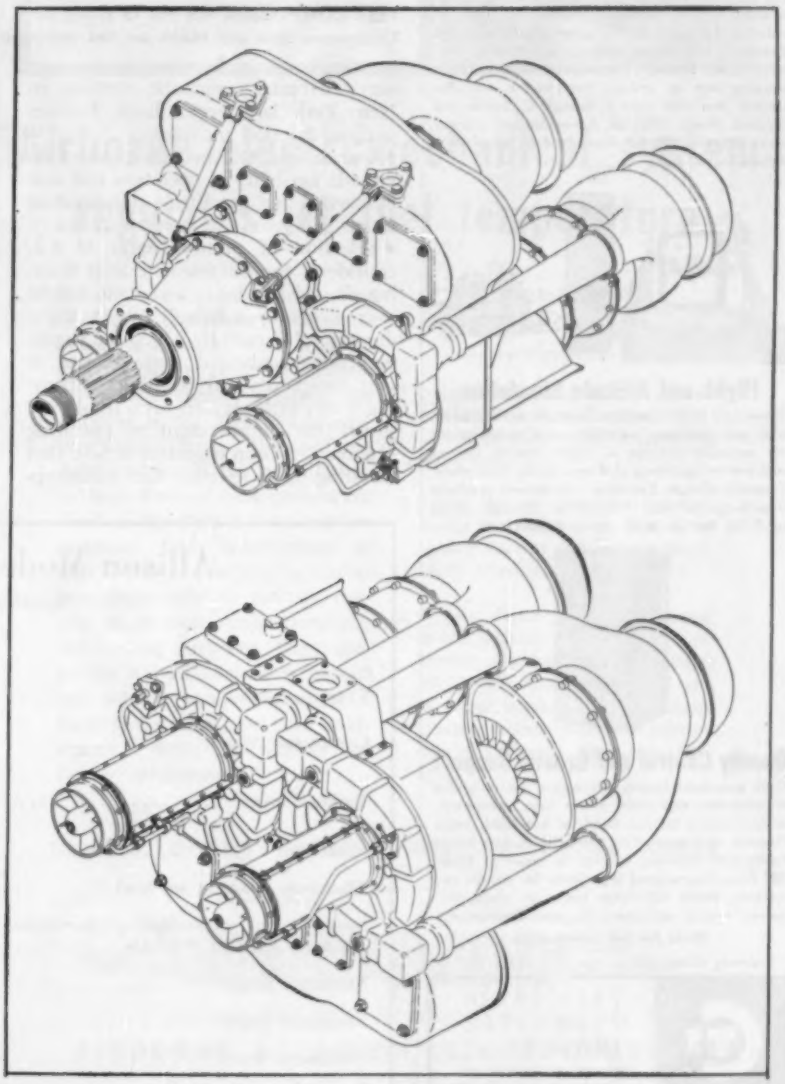
Two versions of the T63 are concurrently in development for the U.S. Army: a propeller-drive type designated YT63-A-1 and a shaft-power version designated YT63-A-3. Company model number is 250. Allison states that it as yet has no specific installations for the powerplant, but sees applications for both fixed wing and rotary wing aircraft, and also aerial platforms and drones. The company reports that its agreements with the Army provide for producing commercial versions of the engines concurrently with military schedules. In addition to being a prime mover, the T63 is also seen applicable to numerous utility functions, such as a turbine engine starter, for marine propulsion and other portable power uses.

Current program calls for making the first run of the engine this spring, with tentative development schedules calling for 50-hr. test in the latter part of 1960 and completion of 150-hr. test and first production engines a year later.

Key areas of T63 design approach were covered by Allison chief preliminary design engineer Russell S. Hall during the Society of Automotive Engi-



REAR VIEW shows combustion chamber (bottom) on T63 mockup.

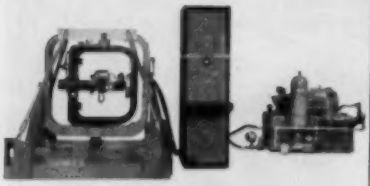


TWIN DEVELOPMENT (Model 252) delivers 500 hp. Propeller-drive version is at top, shaft-drive type at bottom. Most components are of T63; new gear reduction is used.

your avionic
TESTING PROBLEMS
SOLVED!

Radome Boresight Error

The CTI Radome Boresight-Error Measuring System satisfies MIL-R-7705A(ASG), including type II radomes. Boresight error is automatically recorded directly in milliradians with an accuracy of ±0.1 milliradian. Percent transmission and antenna patterns with or without the radome are also plotted. Available from S through K_a bands and infrared. Model 150C for monopulse and conical scan, Model 150B for bombing-type and other shaped-beam radars.



Flight and Altitude Simulation

Three-Axis Flight Simulator reproduces roll, pitch, and yaw positions, velocities, and accelerations for accurate analysis of flight control systems and inertial guidance platforms in the laboratory. Dynamic Altitude Simulator (not shown) produces 0-to-10-cps altitude fluctuations through range of ±700 feet at levels up to 80,000 feet.

Quality Control and Ground Support

Only automatic testing can assure the reliability of electronic equipment where time, manpower, or accuracy is critical. Used for pre-flight, maintenance, and production tests, CTI devices locate faults and incipient failures in seconds. Model 180 Tape-Programmed Supertester for circuits and systems; Model 165 Cable Tester for wiring harnesses; custom equipment to your requirements.

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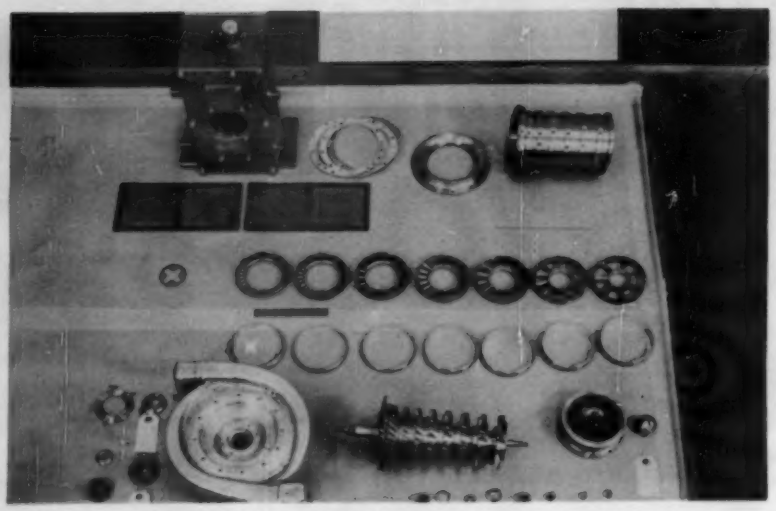


TEST COMPRESSOR was run in spring 1958 to validate efficiencies of small component. Compressor disks and blades are cast one-piece and stacked, may be made of plastic later.

neer's national aeronautic meeting in New York last week. Basic features outlined by Hall included:

• **Use of free turbine** configuration to provide flexibility of operation and ease of starting and permitting optimization of gas generator and power turbines.

• **Selection of pressure ratio** of 6.2, considered the intermediate level favoring desired reliability and light weight over economy—relatively short flight duration of aircraft for which the engine is planned indicated that increase in cost, complexity and weight accompanying a very high pressure ratio would not justify the improvement in operating economy. Allison engineers believe that resulting 0.70 specific fuel consumption at military power for which the T63 is designed is consistent with their basic objectives.

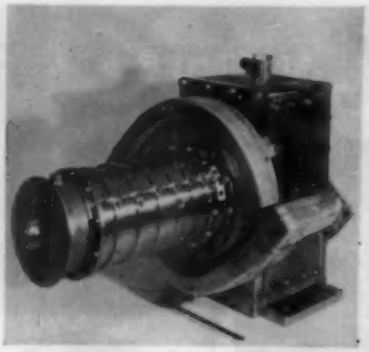
• **Turbine inlet temperature** limit of 1,750F was decided upon to give improved operating margin in blade stress rupture characteristics and extend the engine's operational life and reliability.

• **Airflow** of 3.0 lb./sec. was selected to provide engine with full power capability of 250 hp. on a 100F day without exceeding engine temperature limits. This airflow rate to provide full power capability on a hot day provides an extra benefit in that the turbine inlet temperature will be significantly less than the selected peak at full 250 hp. rating on all but days when the

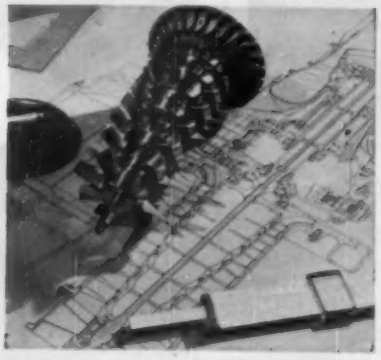
Allison Model 250 (T63)

Specifications

	T63 Turboprop	T63 Turboshaft
Type	Free turbine	Free turbine
Compressor stages	7 axial 1 centrifugal	7 axial 1 centrifugal
Turbine stages	1 gas producer 2 power turbine	1 gas producer 2 power turbine
Combustor	Single	Single
Maximum power at sea level	250 eshp.	250 eshp.
Specific fuel consumption, maximum power, standard 59F day	0.70 lb./hr./eshp.	0.70 lb./hr./eshp.
Maximum height	19.5 in.	19.5 in.
Maximum length	38.5 in.	34.6 in.
Maximum width	15.8 in.	15.8 in.
Dry weight, minus tailpipe	110 lb.	95 lb.



SMALL COMPRESSOR design indicated use of centrifugal last stage, saving at least three axial stages and allowing efficient delivery of air to scroll for passage to combustor.

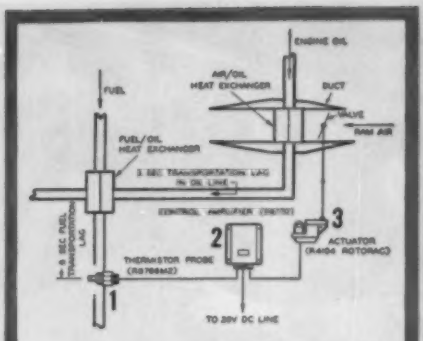


ambient temperature is 100F or higher, further extending component life, Hall pointed out.

A major problem in small turbine engine design is developing an effective arrangement of its parts to maintain the smallest possible envelope. Compared to larger turbine powerplants, major elements of the small engine are badly out of proportion, Hall noted. As examples he cited the combustion area: quenching effects in this chamber dictate the use of not more than one or two chambers. The combustion chamber therefore tends to become unwieldy in size and will not fit neatly into the small engine's outline; main reduction gear, accessory drive gear and the accessories are disproportionately large when compared to the main power producing portions of the engine. Indications are that in the accessory field, at least, there exists a new area of product development to satisfy the small turbine potential market.

Basic Configuration

In the basic configuration engineered by Allison, air is taken into a compressor having seven axial stages and a single centrifugal stage. From the compressor the air is angled sharply through a vaneless diffusor to a collector scroll, angled again to flow through two external tubes—one on either side of the



AIRBORNE R8010 TEMP. CONTROL SYSTEM

Schematic diagram of temperature control system developed by Airborne for use on Martin P6M-2 Seamaster. System operates on 28 v d-c, maintains fuel temperature at approximately 200°F. by monitoring ram air flow to air/engine oil heat exchanger. Oil is used in turn to heat fuel.

Airborne electromechanical system regulates jet fuel temperature

Besides offering an extensive line of linear and rotary actuators, Airborne can also meet your requirements for complete electromechanical control systems. An example is the R8010 Temperature Control System designed and developed for Martin and illustrated here. Four of these systems are used on the P6M-2 Seamaster to maintain fuel temperature at 180-220°F. If you have a similar requirement—for an aircraft, missile or ground application—why not contact Airborne. Our capabilities in special actuators, motors and related equipment make it likely that we can meet your needs exactly. Write or phone for further information.

AIRBORNE R8010
Temperature Control System
General Engineering Data

1. Probe: Sensitive thermistor type mounted in MS10057-12 fitting. Resistance—nominally 10,000 ohms at 200°F.—varies with temperature.
2. Control Amplifier: Transistor-relay type. Service temperature range from –65 to +200°F. Vibration and shock per MIL-E-5400A. Acceleration to MIL-E-5272A.
3. Actuator: Partial-revolution, conforming to MIL-A-8064A. Motor—26 v d-c, reversible, continuous duty, conforming to MIL-M-8609. Actuator speed—.12 rpm at normal torque of 84 in./lb. Design incorporates electric clutch, limit switches, positive mechanical stops, radio noise filter.

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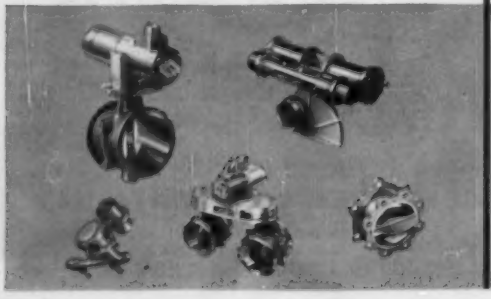
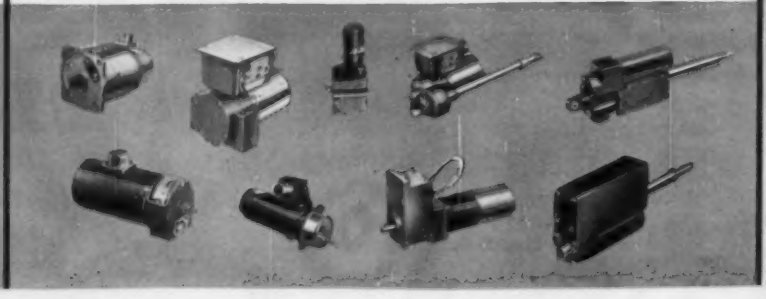


ACTUATORS — Rotary and linear types featuring a wide range of gear reductions, switching and mounting details. Available either as standard units or special designs to fit various applications. Designed to applicable military specifications.



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Of rugged, lightweight construction, Barber-Colman check valves have completed more than 10,000 surge cycles without appreciable wear. They pass 10 G vibration.

Pressure drop is very low. For a typical 2.5" unit, total leakage does not exceed 0.1 pound per minute for any combination of air temperature from 80°F to 900°F and air pressure from 5 psig to 210 psig. For most combinations, leakage is less.

In addition to those illustrated, other Barber-Colman check valves can be designed to your requirements. Consult the Barber-Colman field engineering office nearest you — New York, Los Angeles, Baltimore, Rockford, Ft. Worth, Seattle, Boston, Montreal. Or write direct for free Barber-Colman air valve catalog.

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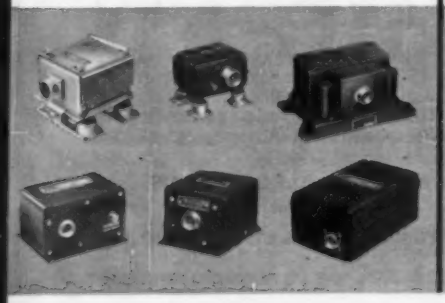
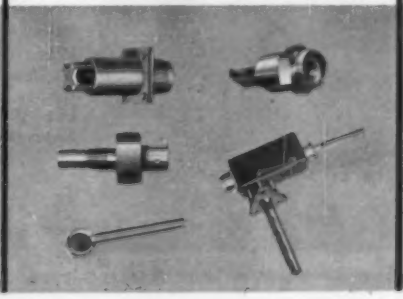
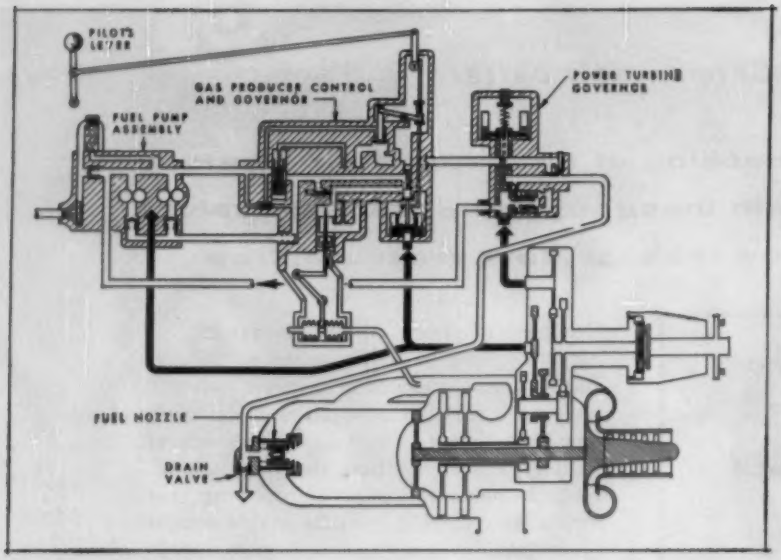


TRANSDUCERS AND THERMOSTATS — Units for sensing compartment, duct, windshield temperatures. CEDAC system senses, controls temperature and/or airflow in ducts.



TEST EQUIPMENT — Compact electrical test units for quickly checking all components of a Barber-Colman control system installed in an aircraft. Special units for checking many electrical systems.



SIMPLE mechanical-hydraulic engine control system eliminates electronic components entirely, considers the pilot as the computer-servo mechanism for necessary functions.

engine centerline—into the single combustion chamber which is placed coaxial to the compressor turbine shaft. Combustion chamber is at the aft portion of the engine; hot gases move forward from the combustion chamber through the turbine area and into an exhaust hood in the middle of the engine and are then exhausted downward.

Main structural element of the T63 is the gear box casting. The compressor assembly is bolted to the forward face of the gear box and the turbine-combustor section, including exhaust hood, is bolted to the aft face. The gear case contains the spur gear train which engages a small gear on the power turbine shaft and transmits output power vertically upward to a horizontal shaft above the engine's center line.

Output shaft turns at 6,000 rpm. A planetary reduction gear box, having provision for mounting a propeller shaft, can be attached to the forward face of the gear box engaging the 6,000-rpm. output shaft and delivering output power of the engine to the propeller hub at 2,000 rpm.

Gear Train

A spur gear train is included in the gear box, engaging a gear on the gas generator turbine shaft, to provide connections to engine accessories pads on the gear box.

With the complete compressor assembly and turbine-combustor assembly bolted to the gear box, much in the same manner as the starter, generator, fuel control and propeller reduction gear, main elements can be removed and replaced about the same as the accessories, Hall noted.

In addition, this engine arrangement lends itself to twin configurations providing 500 shp., he reported. Design studies have been completed. Twinning is accomplished by using a new gear box casting providing for mount-

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T63 Timetable

Mar. 10, 1958—Formal proposal on Model 250 (T63) presented to military services.

Spring, 1958—Test compressor built and run.

June, 1958—Allison receives T63 development contract.

Nov. 18-20—Mockup review conducted to establish production configurations for propeller-drive and helicopter versions.

Early spring, 1959—First run of engine expected.

ing of two compressor and turbine sections and a propeller reduction gear capable of handling the doubled power output. Twin configuration of the T63 is designated Model 252.

In the T63, matching of compressor and turbine components has been done to favor cruise performance. Match point of the gas generator, represented by full output pressure ratio and temperature, could be plotted placed off the maximum efficiency area of a power turbine map so that cruise point will lie in the maximum efficiency area. This approach results in optimum specific fuel consumption for the lower cruise powers at a nominal penalty in maximum power sfc.

Compressor Design

Selected values of 6.2 pressure ratio and 3.0 lb./sec. airflow represented a compressor design problem at the fringes of the presently well established art, according to Hall. Small size, high speed, low Reynolds number and high pressure ratio in combination represented an area where there was a lack of adequate empirical data, he noted, making prediction of compressor performance uncertain.

The axial compressor configuration was chosen for the forward, low-pressure portion of the unit because of high efficiencies obtainable compared to the centrifugal type and the difficulty of obtaining a 6.2 pressure ratio with the latter configuration of such small size.

With the Reynolds number being of extreme importance in the design, selection of parameters had to be such to provide blades with large chords, passages with the greatest possible space between blades and with great radial depth while maintaining blade aspect ratio as high as possible.

Centrifugal compressor was selected for the last stage. Despite the very low hub-to-tip ratios selected to maximize the Reynolds number, axial blades become too short radially in the final stages. Centrifugal type impeller can be used to replace at least three axial stages and because of the centrifugal

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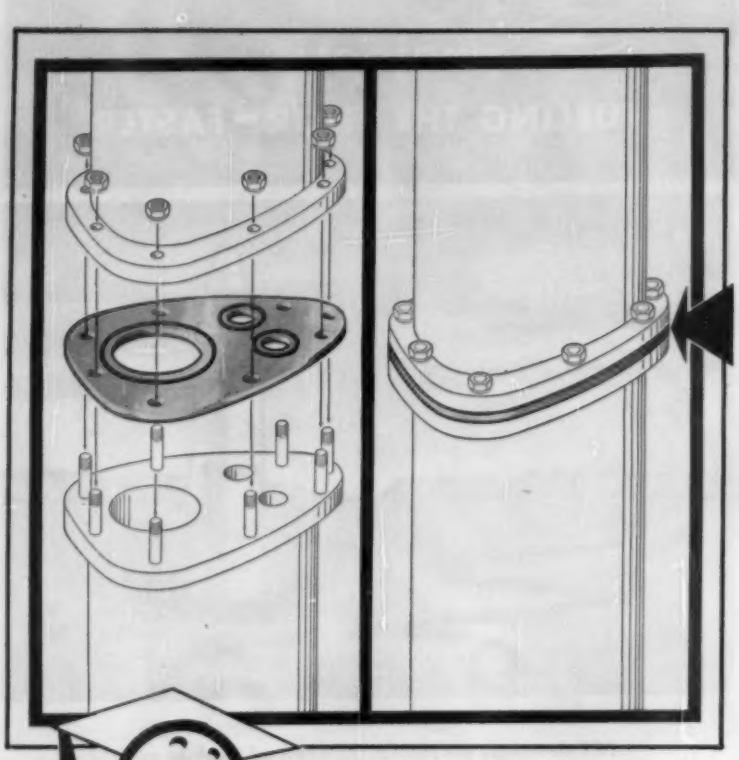

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force along the flow direction in much better suited to handle the well-developed boundary layer, Hall noted. Also, due to the limits placed on the number of combustors in such a small powerplant, compressor air must be collected in a scroll prior to its passage to the combustors, he said. A centrifugal type rotor can be designed to occupy space required to deliver air to collector scroll and achieve compactness.

To avoid undesirable stall effects, the centrifugal element of the compressor was finally designed with a vaneless or vortex type diffusor.

Engine control system is simplest possible mechanical-hydraulic type relying on the pilot where possible and eliminating electronic components completely. Pilot will control the engine by watching a turbine gas temperature indicator—in event of over-temperature operation on the engine, the pilot would adjust the throttle setting to bring temperature within limits. A torque indicator would be utilized by the pilot to avoid indicated limits, since the engine could run over 300 shp. normally if allowed to go to full rated temperature.

Helicopter installation would provide connection of pilot's lever to the power turbine governor to permit selection of helicopter rotor speed. Normally, the lever would be moved to the maximum speed position so that the governor acts as an overspeed prevention device. Since under this system, the power governor would have taken over the fuel control function, the gas generator will increase or decrease power on demand.

PRODUCTION BRIEFING

General Electric Co.'s Jet Engine Department, Cincinnati, Ohio, has received an $8,300,000 Air Materiel Command contract for further development of the J93 chemical engine.

Turbo Dynamics Corp., Los Angeles and Minden, Nev., has acquired ownership of Suburban Engineering Co. College Park, Md., as its sixth subsidiary in its program of expansion.

Martin Co. has received a $2,400,000 USAF Air Materiel Command contract for expansion of the TM-76B Mace.

General Electric Co. has been awarded a $5 million National Aeronautics and Space Administration contract for development and delivery of a liquid propellant rocket engine to power the second stage of the Project Vega vehicle (AW Mar. 2, p. 18). Engine will be a further development of the Vanguard first-stage powerplant with an ignition system designed for repeated starts at high altitude.

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For additional information, call your nearest CEC sales and service office or write for Bulletins CEC 1568-X35 and 1588-X9.

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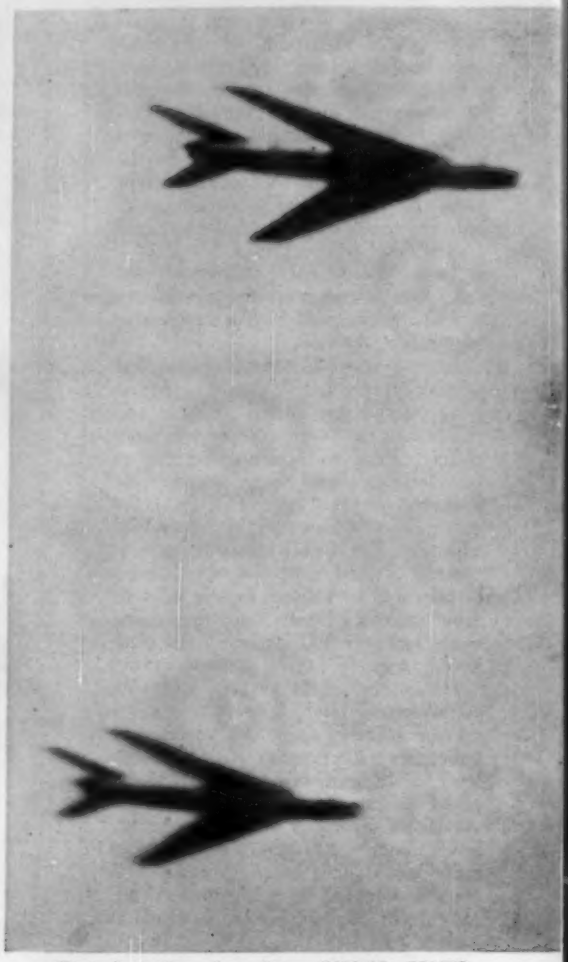
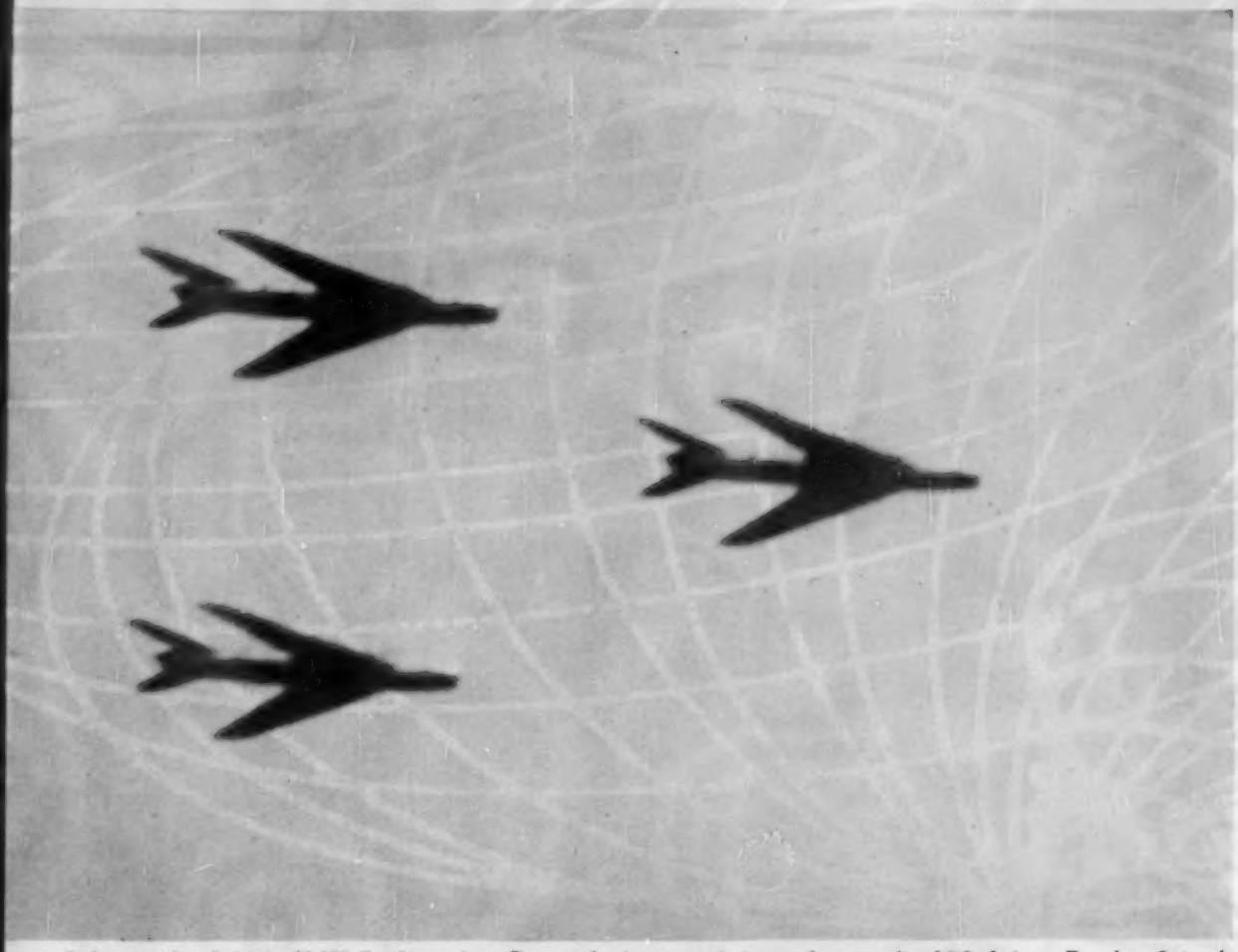


First formation shot shows MiG-21 (NATO code-name Faceplate), latest Soviet design in Mikoyan series. Single nose air intake and large tailpipe orifice indicate switch back to

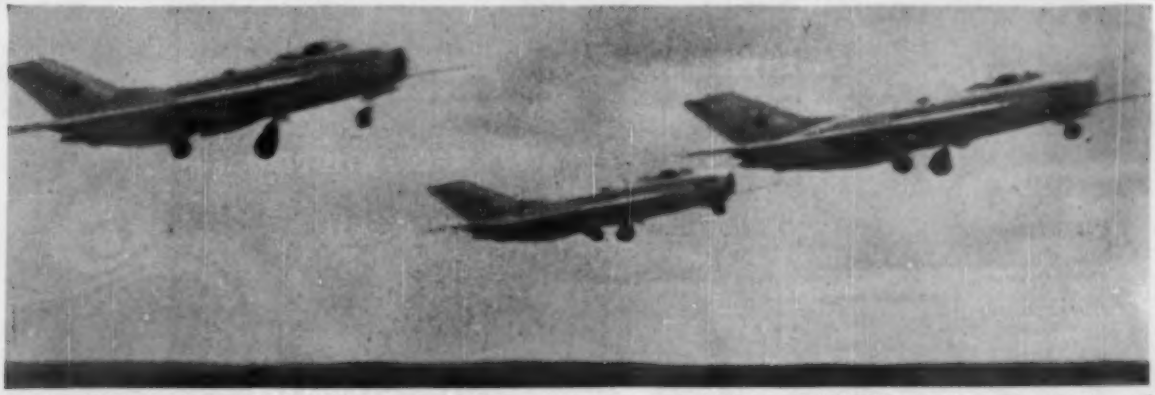
Formations

MiG-17 (NATO code-name Fresco) formation (left above) shows modifications added to later models including addition of ventral fin on rear fuselage, special heat-resistant metal panels on rear fuselage where afterburner for the centrifugal flow turbojet based on the Rolls-Royce Nene design is housed, and fuselage bulge near tail, possibly housing afterburner tailpipe controls. Note 37 mm. cannon protruding just below serial numbers on nose, external fuel tanks, and three wing fences to improve chordwise flow across highly swept wing. MiG-17 is now standard operational fighter for Soviet satellite countries and is being phased out of Soviet Air Force first-line units. Top speed is about 700 mph. Closeup air-to-air photo (left) of MiG-19 fighters shows switch to low-set horizontal stabilizer, bifurcated tailpipe for twin-engine installation, single large wing fence.

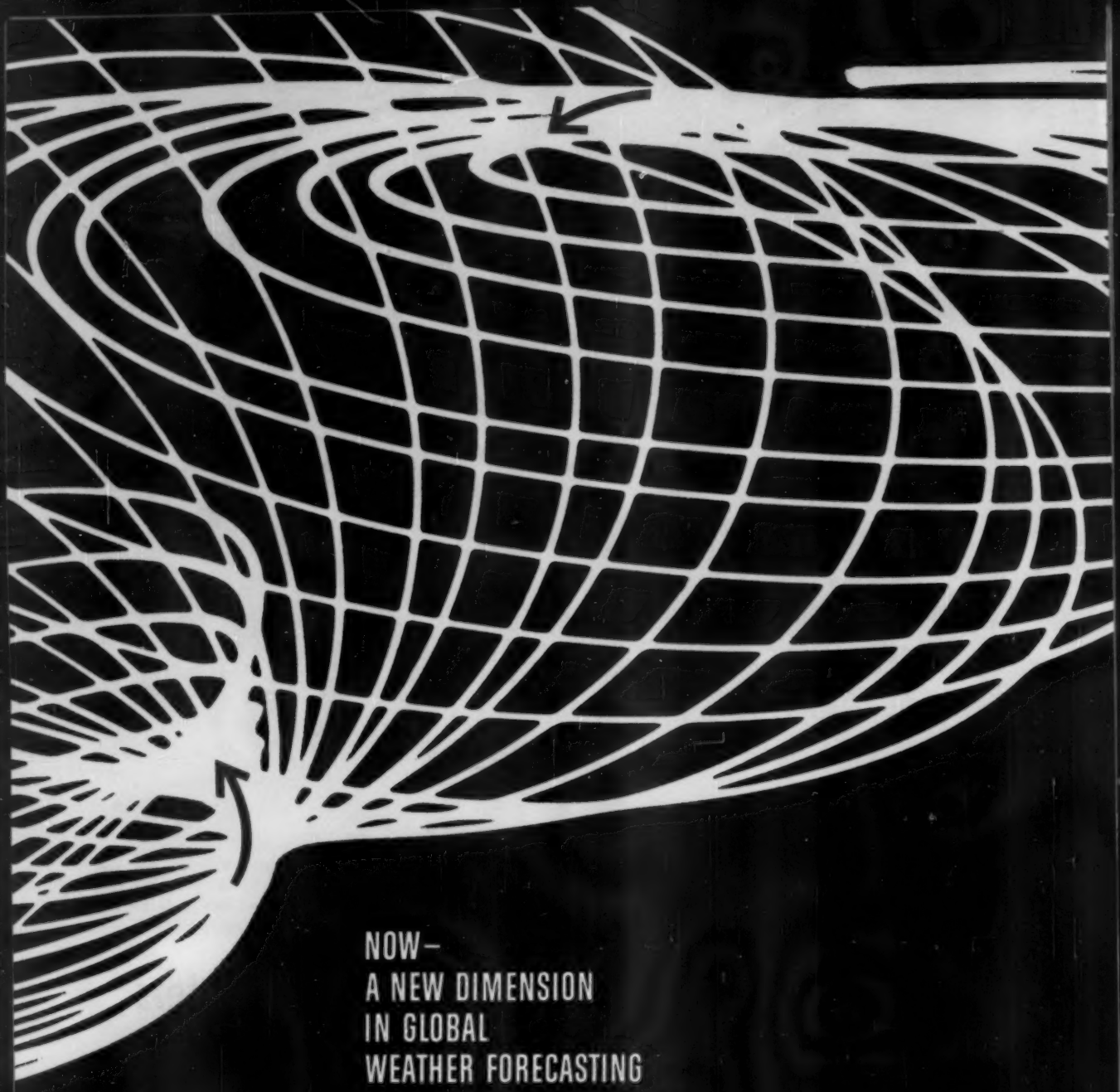


single large axial turbojet in 22,000 lb. thrust class. Degree of wing sweep is increased over earlier MiG designs. Faceplate first publicly flew in prototype form at 1956 Tushino air show and is now in production. It is being introduced into Soviet Air Force operational units in key areas. Speed is in 1,200 mph. class with some versions reported to be fitted with a rocket assist unit for high altitude combat.

Show Design Details of Operational Soviet Fighters



Scramble takeoff is made by MiG-19s (NATO code-name Farmer) at an operational Russian airfield. Note landing gear retracting and relatively small tailpipe diameters in contrast to main fuselage diameter. MiG-19 is now standard first line Soviet Air Force fighter with top speed around 1,000 mph. and service ceiling of 60,000 ft. MiG-19 has combination of old-fashioned mast antenna and modern stub antenna on fuselage. Aircraft has two small diameter, high thrust axial-flow turbojets of about 8,000 lb. thrust each, dual air intakes and tailpipes.



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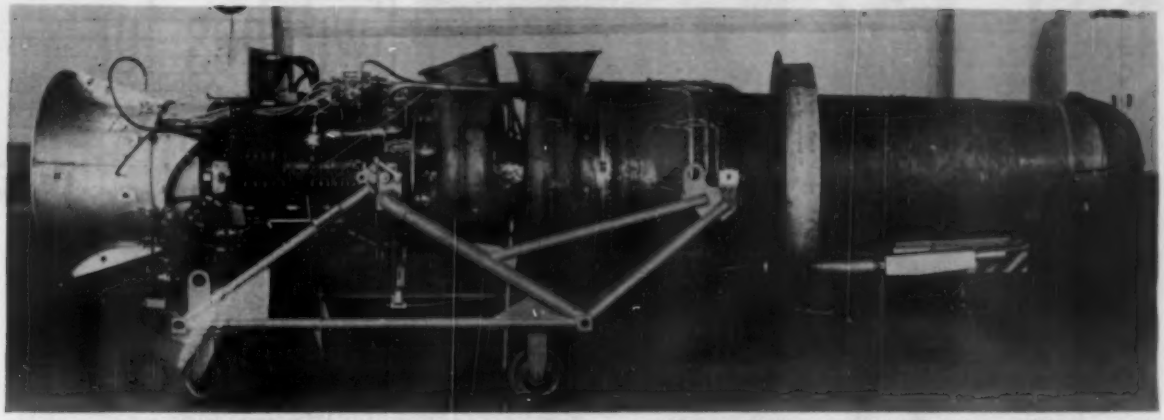


FIRST jet engine in the U. S. operated solely on nuclear power was the General Electric X-39, a modified J37. Main modification is the two scrolls replacing the combustion chamber to drive air to and from the nuclear reactor located at the side of the engine.

Part II: Nuclear Aircraft Program

Scientists Aim at Nuclear Plane Test Data

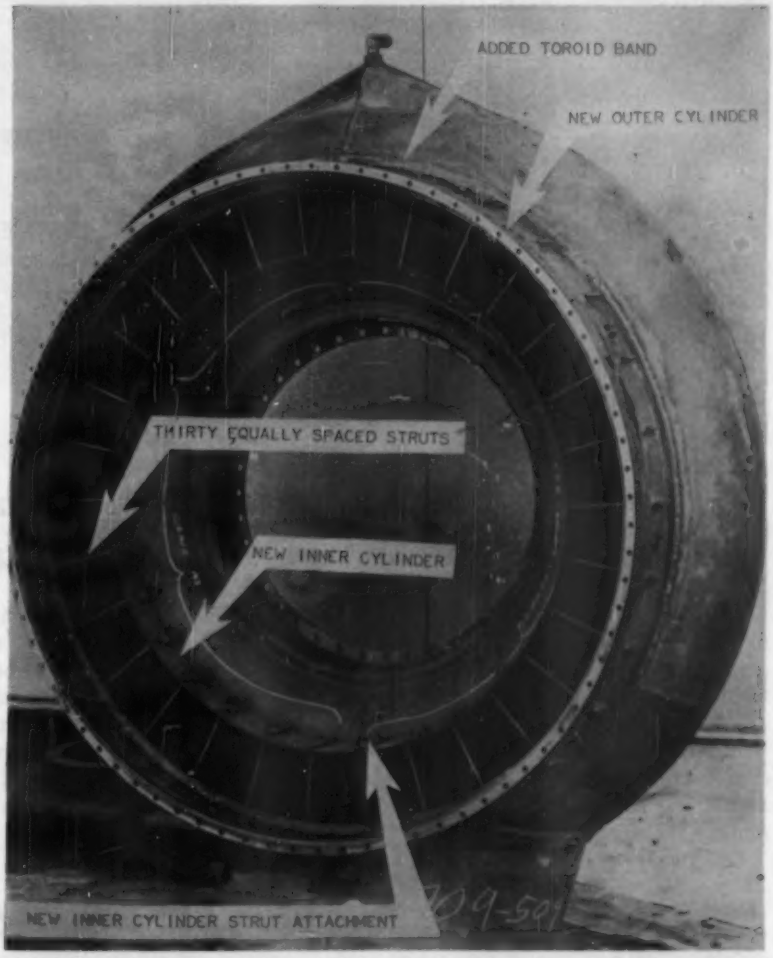
By J. S. Butz, Jr.

Washington—Feasibility of the principal systems and the broad design approaches needed for construction of a subsonic nuclear aircraft have been clearly established during the eight years since applied research and development work was initiated in this field within the U. S.

Available data existing for these nuclear aircraft systems has been gathered primarily by experimentation and testing rather than through the development of exact theory which could be used to design the systems needed for any specific nuclear aircraft. Indications are that such exact theory will not exist for many years, if ever, and that nuclear aircraft design will be largely an empirical matter just as the design of conventional aircraft is today.

W. E. Edwards and J. E. MacDonald of General Electric Co., in discussing shield design in a recent technical paper, said, "Exact methods of shield analysis are not yet available. Perhaps computing machines available now or at least those available in the future will bring exact methods into the realm of feasibility. Even then, the accuracy of the methods will depend on the equality and quantity of basic data available."

So many variables affect these basic data that most authorities agree it will not be possible to develop exact shield design techniques for a number of years. However, Convair, General Electric and Lockheed, the three firms who probably have done the most work on the aircraft shielding problem, agree that it has been proven that empirical methods are adequate to produce shields



TURBINE scroll is typical of those which have been used on the several dash numbers of the X-39 which have been tested. Asymetrical flow through scrolls and engine is unusual.

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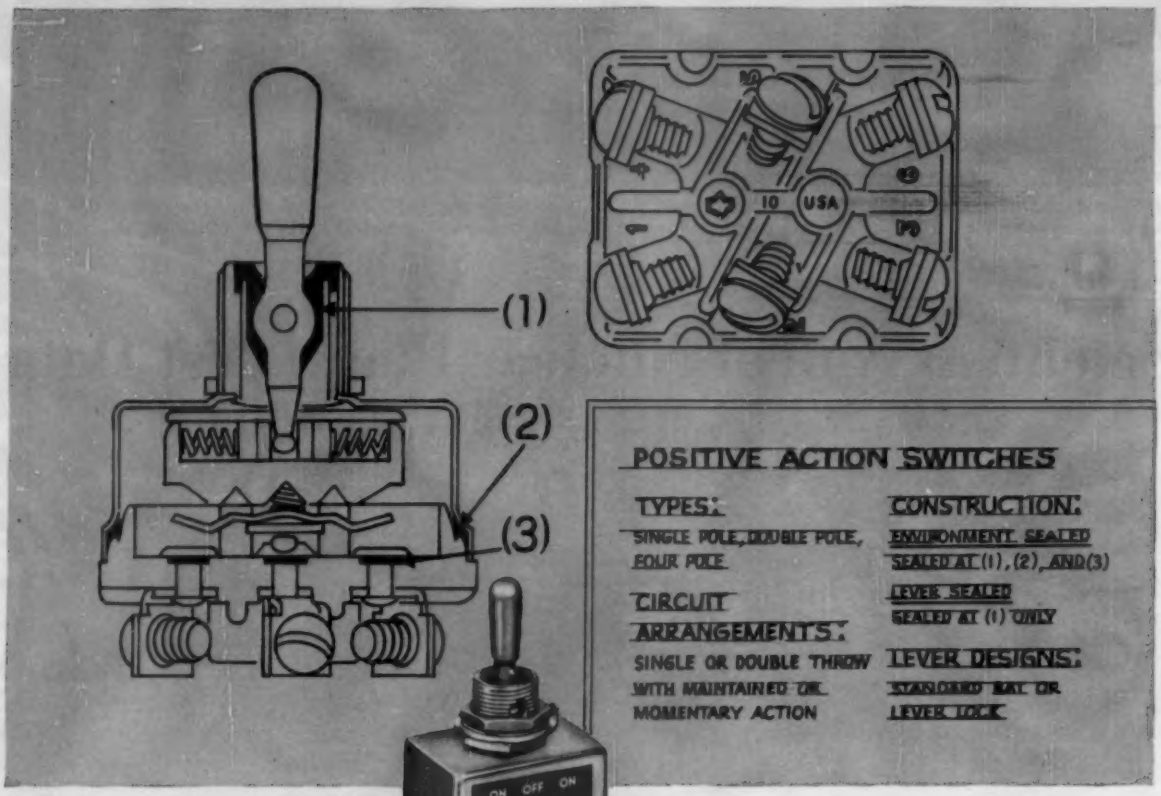

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Entirely new—designed and built to perform infallibly. These switches meet Mil S-8834. They are available in the environment-sealed type, with new terminal seal, body seal and molded lever seal—or lever-sealed type, with molded lever seal only.

Wiping contacts insure perfect switching for low energy circuits. Direct toggle-to-contact mechanism makes the switching action positive, insuring safe, reliable switching on high energy circuits.

One degree of lever throw opens the circuit. The contacts make and break independent of any spring pressure. These switches have positive detent action —they cannot be teased.

A new insulating material provides improved arc-tracking resistance and excellent voltage recovery. Staggered terminals permit maximum clearance for easier wiring. Circuit arrangements are unlimited. Available with either standard toggle lever or new lever lock. Write for Publication EA168-G-286. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

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light enough for use on subsonic aircraft which gross around 300,000 lb., carry larger payloads than conventional aircraft of the same size and allow greater than current utilization of flight crews.

Similar statements have been made about the adequacy of present empirical design methods for the other systems needed for a nuclear aircraft. The time required to build and flight test a subsonic nuclear aircraft using these methods is estimated by Atomic Energy Commission and Air Force contractors at somewhere between three and five years (AW Mar. 30, p. 86).

Compilation of papers presented on nuclear aircraft shows that many of the design approaches to these four critical problem areas already have been clearly defined:

- **Reactor and engine.**
- **Shielding.**
- **Materials.**
- **Ground handling and maintenance.**

Type of nuclear turbojet in the most advanced state in the U. S. is the direct cycle with the engine air passing through the reactor to cool the reactor as well as to provide thrust. This type of engine has been in development for eight years by General Electric, which has run a modified J47, designated the X-39, for 100 hr. on nuclear power alone.

Several reactors have been run in combination with various dash numbers of the X-39 during the General Electric experiment at the AEC test site at Idaho Falls, Idaho. The reactors had all been placed to the side of the turbojet so that considerable redesign was necessary to convert the J47 to the X-39.

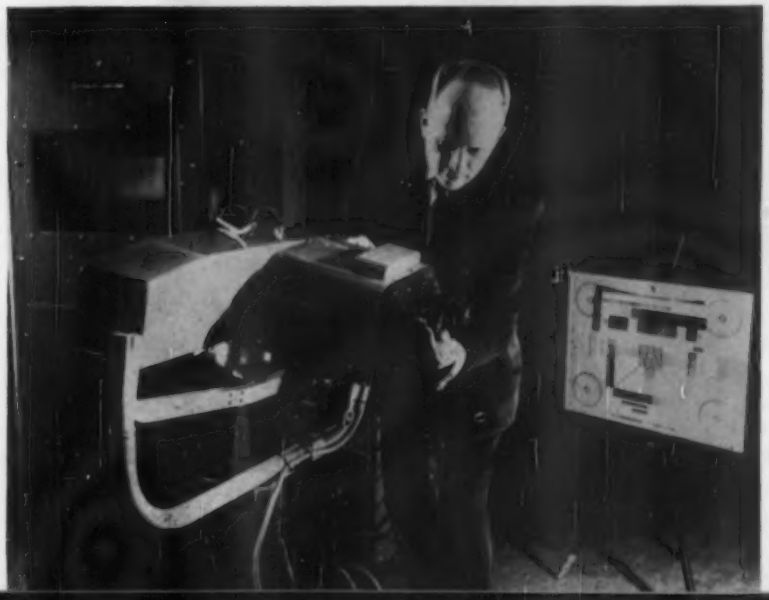
First problem was the much higher pressure drop through the reactor and its connecting piping than had existed on the turbojet using a chemical fuel burner section. This left the compressor and the turbine in a badly mismatched condition. To solve the problem, initially, the compressor was modified to supply less air than in the original design.

Two scrolls also were designed, one to deliver the compressor air to the heat exchanger reactor and one to send the air back into the turbine. These scrolls are unsymmetrical and, therefore, unique among normal turbojet components, and they have caused problems in vibrational analysis which have not yet been resolved theoretically. Model testing is the only design approach now available for these engines. Eventual hope is to be able to reduce the diameter of the reactor and its basic shield to a small enough figure to fit into the turbojet and eliminate the side position of the heat source and the need for scrolls.

Two other major problems with

OPERATING the "Handyman" manipulator, project engineer Ralph Mosher places his hands in gloves which put pressure on his fingers, giving him a "feel" for work he is performing.

MANIPULATOR capabilities include carpentry (above). Three dimensional color TV camera (below) gives remote control engine mechanic a view in depth to control "Handyman."



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these scrolls is their tendency toward uneven pressure distribution and high temperature spots.

Design of small high power density reactors such as the type needed for the nuclear aircraft is involved and dependent upon a number of variables. Basically, the aircraft reactors being developed today are about 4 ft. in diameter and approximately 4 ft. long.

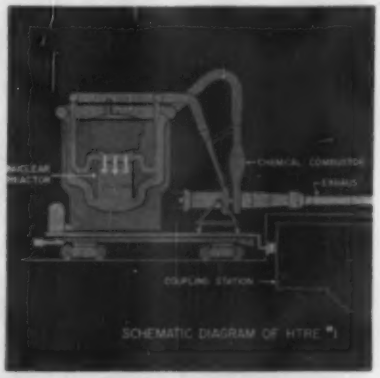
They must be kept small in order to reduce shielding weight, keep pressure losses low and to operate at highest possible temperature and improve heat transfer between the reactor and the engine air.

Fuel elements and their placement in the reactor must be handled with great care if the efficiency of the system is going to be high enough for flight use. The power fluctuation across the reactor core and the separate elements should be near zero, and, longitudinally, it should be peaked toward the forward end of the core to get this necessary efficiency.

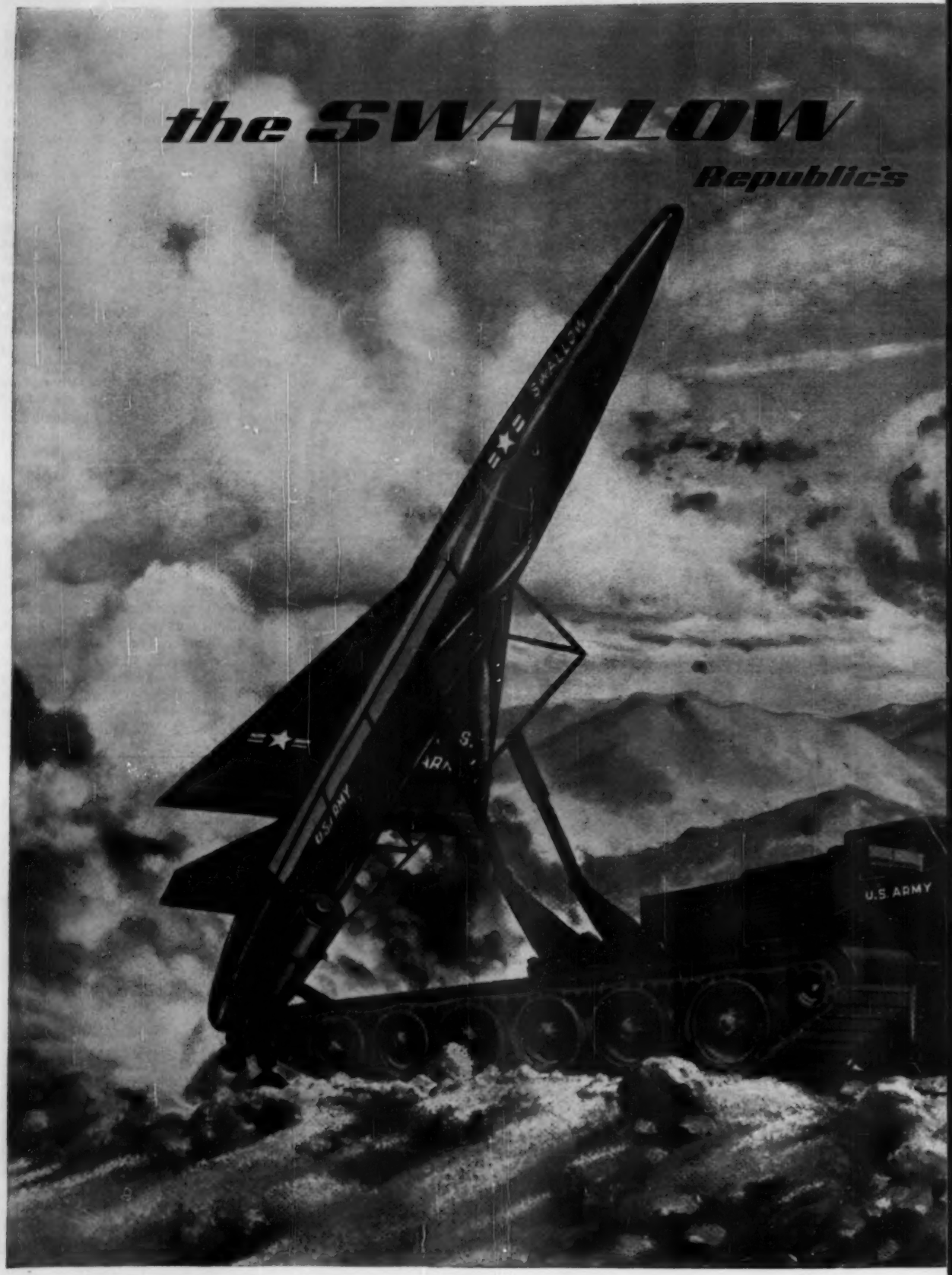
Two general methods have been tried to achieve these power profiles—adjusting the placement and amount of fuel in the separate elements and varying the spacing between the elements.

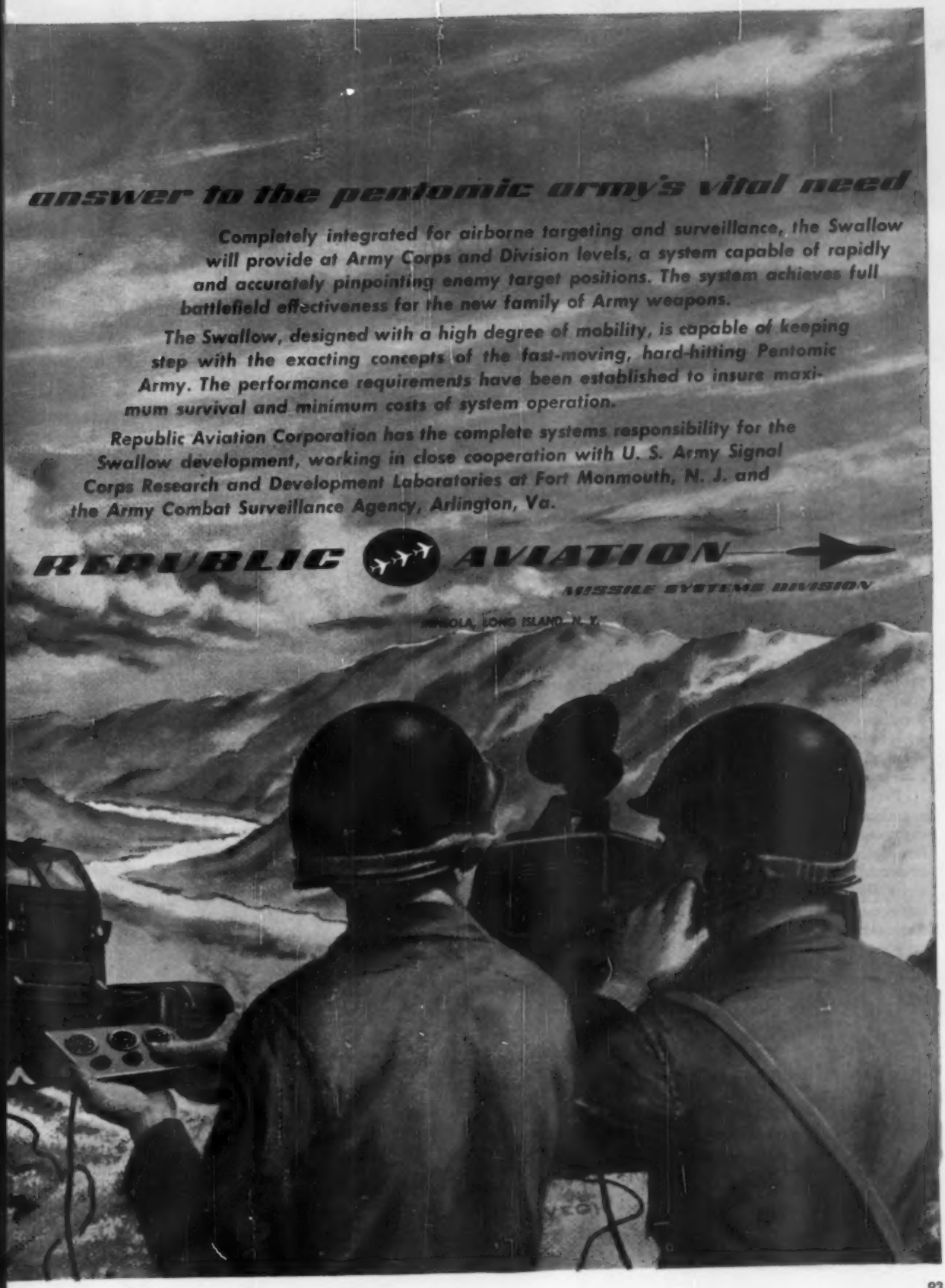
The air spaces between the fuel elements greatly complicate the job of determining the criticality of the reactor, because they are separated by air spaces and are, therefore, somewhat self shielding. This also raises the size of the critical mass. Neutrons also tend to stream out of the reactor in the air spaces and upset normal calculations to determine the criticality and reactivity of the reactor.

Usual types of reactor materials have proven to have mixed blessings for aircraft use. For instance, graphite which is a good material for neutron reflectors, gives a very bad power peak in the outermost tubes of a heat exchanger reactor. This can only be corrected by



SCHEMATIC of the test rig for operating turbojets on atomic power has the reactor in very large vessel with much more shielding than is needed for the divided shielding needed in an aircraft.


the SWALLOW
Republic's
U.S. ARMY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Republic Aviation Corporation has the complete systems responsibility for the Swallow development, working in close cooperation with U. S. Army Signal Corps Research and Development Laboratories at Fort Monmouth, N. J. and the Army Combat Surveillance Agency, Arlington, Va.
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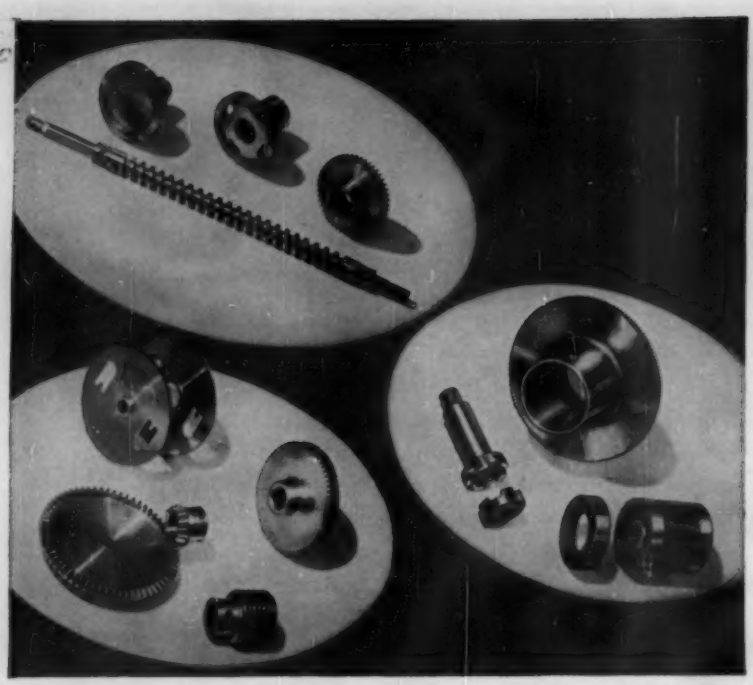

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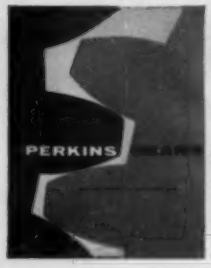

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CERAMIC coated circuit components are used in radiation and high temperature resistant amplifier above. Work with such units has proven the feasibility of electronic equipment in controls near reactors.

an empirical adjustment of the fuel distribution.

Control of the reactor and its turbojet can be simplified, according to General Electric, so that the pilot of a nuclear aircraft will have powerplant controls similar to those on a conventional jet engine. The reactor will have a number of control rods which will be carefully withdrawn during the starting period. Starting period itself probably will be automatically controlled and rather lengthy.

Power Curve

After the start, the power curve will flatten out for most reactors and rather rapid changes in power will be possible. Though these power changes will not be quite as rapid as that possible with chemical fuel turbojets, they probably will be as rapid as the engine's rotating machinery can take. This may eliminate compressor stall, surges, etc. Acceleration characteristics of the nuclear aircraft would then be somewhat worse than those of present-day bombers.

Several automatic systems and their necessary sensing elements which can make it possible for essentially one-lever control of the nuclear turbojet have been studied at length by General Electric. Basic components of these systems are reactivity control elements or rods, thermal and nuclear sensors and actuators. All of these components will have to function in a high radiation field near the reactor, and, during the past eight years, it has been proven by General Electric that such components can be built with a satisfactory service life.

Probably three sets of instrumentation will be necessary to precisely monitor the nuclear activity of the reactor. The first will be needed during the starting period when the neutron activity is small; another will be needed at the end of the starting period when rapid power changes are taking place; the third will take over when the reactor is on the power step and ready for flight.

Automatic systems which will be used

to control the nuclear powerplant have two main functions—to keep the power level of the reactor nearly equal to the demand level and to keep the multiplication factor at approximately zero. The multiplication factor also is called the reactivity, and it is determined by the position of the control rods which set the rate at which power may be increased. When a reactor is used in connection with a turbojet engine, this multiplication factor must be close to unity, for rapid increases in power cannot be matched by sudden large increases in the air flow needed to keep the reactor at its prescribed operating temperature.

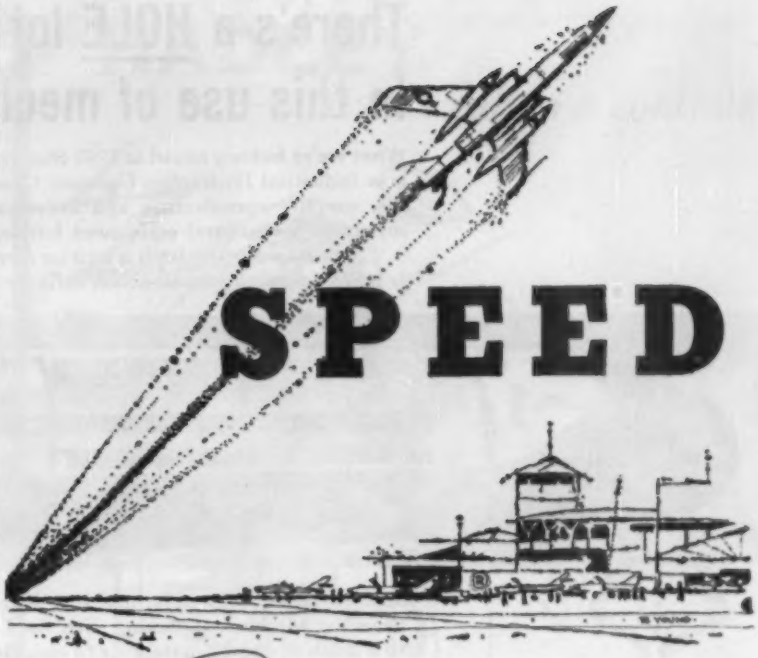
Flight Monitoring

On the nuclear aircraft as it is now planned, the flight engineer will monitor the reactor constantly so that he can manually take control in the event of a malfunction of its automatic control. It has been determined in tests that both the automatic and manual systems are practical.

The only airborne shielding development work conducted in the U.S. thus far has been handled by Convair. A 1,000 kw. reactor was flown in a modified B-36 designed so that it was possible to evaluate 26 different combinations of divided shielding. Tests showed that one of the best tools for reducing shielding weight is to divide it between the reactor and the flight crew's compartment.

B-36 testbed was protected by shielding consisting of layers of rubber and lead. The lead thickness varied from .25 to 2.5 in. and the rubber from seven to 17 in. Only the pilots were provided with windows. These windows were nine to 11 in. thick and formed from Plexiglas and leaded glass. Behind the flight crew compartment there was a half-scale crew shield which could be varied in composition. Be-

OAK RIDGE test setup above was used to irradiate a complete jet engine and determine the nature and life of residual radiation and the length of the cooling period necessary before direct maintenance could be performed. Reactor is in vessel at right.



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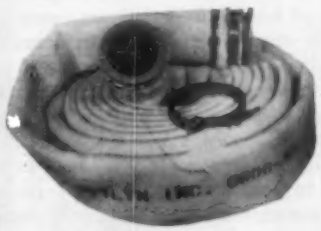

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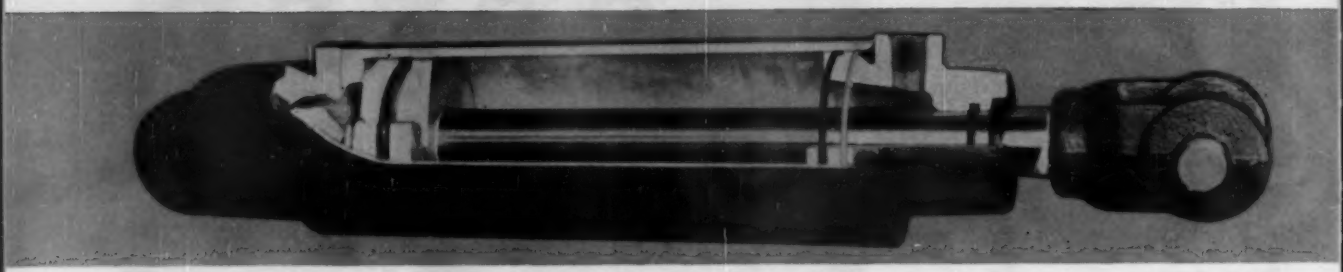
"The cut-away cylinder is a unit we furnish to one of our many customers. This is a 3½" diameter, double-action cylinder used for mounting on pull-behind tools



such as plows, cultivators, and disc harrows. This cylinder uses your Shelby Seamless Mechanical Tubing with the I.D. bored to size and roller burnished to a finish of approximately six to eight RMS. The expected life of this cylinder is in excess of 300,000 cycles, operating at 1,500 psi hydraulic pressure.

"The other cylinder is furnished to another one of our customers, and is a 3¼" I.D. double-action cylinder with a 13" stroke. Used to raise and lower the platform of their self-propelled combine, it is similar to the cut-away cylinder

with respect to finish requirements and material for the barrel. The operating pressure is approximately the same and so is the expected service life of five years, or 300,000 cycles. Generally these cylinders may be serviced for additional use by merely replacing the seals.

"The severe field conditions these cylinders are subjected to are some of the most extreme to which cylinders could be exposed."

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WORLD'S largest periscope, according to General Electric, built to allow close view of reactor and turbojets in operation.

tween this scaled-down crew compartment and the reactor, it was possible to try several varieties of shadow shields. These small shadow shields augmented water shield tanks around the reactor. There were nine of these shield tanks which could be filled in various combinations.

Principal value of this airborne test work was to include the effects of air scatter and airframe scatter on the radiation patterns from the reactor. In all, 47 flights were made with this aircraft to gather radiation data. They ended in March, 1957.

Further investigation to determine the effects of the radiation scatter produced by the airframe of the B-36 were conducted later at Oak Ridge. There, the test reactor and the crew compartment were suspended from 300 ft. towers in the same relative position they had occupied in the aircraft, and the series of shielding arrangements were tested again.

When the shielding is placed near the reactor, it will heat to the point where elaborate cooling passages will have to be provided in the shield to keep it sound over a long period of time.

In general, shield design begins with the setting of the radiator dose to the level that will be allowed the crew and that which can be permitted to reach the various parts of the airframe. Adjusting the weight of the shield around the crew and the reactor will control these dosages.

It was found through the Convair flight tests and through ground experimentation that geometry is one of the most important design parameters for effective shields. Through geometry control it has proven possible to use the aircraft structure around the reactor to great advantage in reducing the level of the radiation reaching the crew compartment and other portions of the aircraft structure.

Ground handling and maintenance has been one of the principal problems concerning the nuclear aircraft, and on

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MATERIALS Testing Laboratory at Idaho Falls is typical of a number which are available in U. S. for testing effects of atomic radiation on aircraft materials systems.

the ground it requires more unconventional procedures than it does in the air.

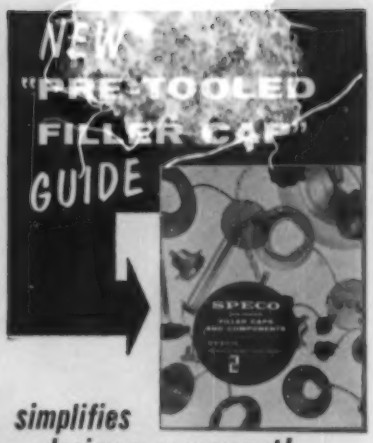
First of all, there must be a completely remote-controlled method for installing and removing the reactor on the ground if it is to be possible to perform major maintenance on a nuclear aircraft that has completed a long mission.

This reactor, which has been producing power for a long period, also will require a system of aftercooling which will have to remove considerable quantities of heat.

It was demonstrated by Convair with the B-36 modified for radiation tests that it was possible to accomplish this remote removal and installation of a reactor.

Probably the most difficult part of the maintenance work on a nuclear aircraft will be on the turbojet engines which will be radioactive after a long flight to the point where men will not be able to work in direct contact with them for a considerable period of time after landing. Test work has shown that airframe maintenance will be more conventional after the reactor, engines and reactor shielding have been removed. After a short cooling period, it is believed that it will be possible to work in direct contact with the airframe.

Most of the devices and installations needed to accomplish all of the remote-controlled maintenance and ground handling which will be required by its nuclear powerplant already have been designed and constructed by General Electric. In many cases, these devices and installations represent considerable



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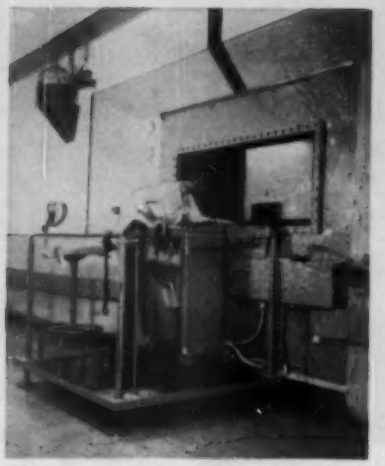

OPERATORS outside of the shielded maintenance shop at Idaho Springs can move heavy units and perform all but the most detailed work on jet engines. They would use three dimensional color television for the detailed operations.

engineering accomplishments. They include:

• **Heavily shielded shop** 50 ft. wide, 160 ft. long and 60 ft. high. Operators watch directly through shielded windows seven feet thick. These operators accomplish gross movements and shifts of equipment within the shop through the use of large manipulators mounted on the walls and on an overhead crane.

• **First three-dimensional** color television developed in the world, according to General Electric. This instrument makes it possible for an operator behind the shield to get a close up picture in depth of the most intricate operations required in the assembly and disassembly of engines. It also makes it possible to use normal color coding of parts, ducting and lines on the jet engine.

• **Manipulator which allows** the operator to feel the tools and parts that he is working with 20 ft. or so away inside of the shielded shop. The operator controls the manipulator by placing his hands in "gloves" which exert pressure on his fingers in almost exact proportion to the pressure he is exerting with the manipulator on the engine parts in the shop. This feedback manipulator called Handyman by General Electric, plus the 3D color television makes it possible for an operator to accomplish maintenance tasks in much less time than that possible in the past. Exact time improvement in the disassembly of a jet engine has not been announced, but General Electric predicts that, with the devices now in existence, it will be possible to keep a nuclear aircraft flying approximately four times longer each year than is now possible with chemically fueled systems.

• **Shielded locomotive** weighing 210

RMC-LINDSAY ONLY GAUGE TO STAND THIS TEST — This photograph shows vibration testing of RMC-Lindsay pressure gauges on the 2200 force pounds Calidyne Vibrator to 50 G output, amplitude .010 to .20. Cycling frequencies to 2,000 cps. The test is conducted so as to parallel actual installation conditions, with gauges subjected to 350°F under operating pressures. Complete test reports are available on request.

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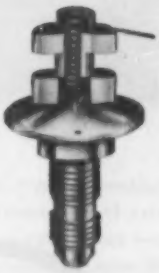

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3. **Superior techniques in coiling, heat treatment, calibration, and material specification are *new* and *exclusive* with RMC.**
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PRESSURE RANGE: Pressures in ranges 0 to 1,000 p.s.i. up to 15,000 p.s.i. with retard scales available. **OVERLOAD PRESSURE:** Nominal overload pressure factor of 2.0 times the maximum dial reading (higher factors available). **BURST PRESSURE:** Normally 3.0 times the maximum dial reading. **TEMPERATURE:** Not affected by temperatures up to 350°F. **VIBRATION:** Qualification test report available on pressure tests showing cycling, vibration, to 2,000 cps. at 25 G's, and resonant frequency vibration tests at 25 G's. **SHOCK:** Data available on MIL-E-5272 shock test. **PULSATION:** Practically unaffected by line pulsations of 3% of the full dial reading. **ENDURANCE:** To 250,000 cycles or higher depending on application. **ACCURACY:** Hysteresis friction and backlash are below readable limits. Absolute gauge accuracy to extremely low limits as required.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write, wire or phone either of the addresses below.

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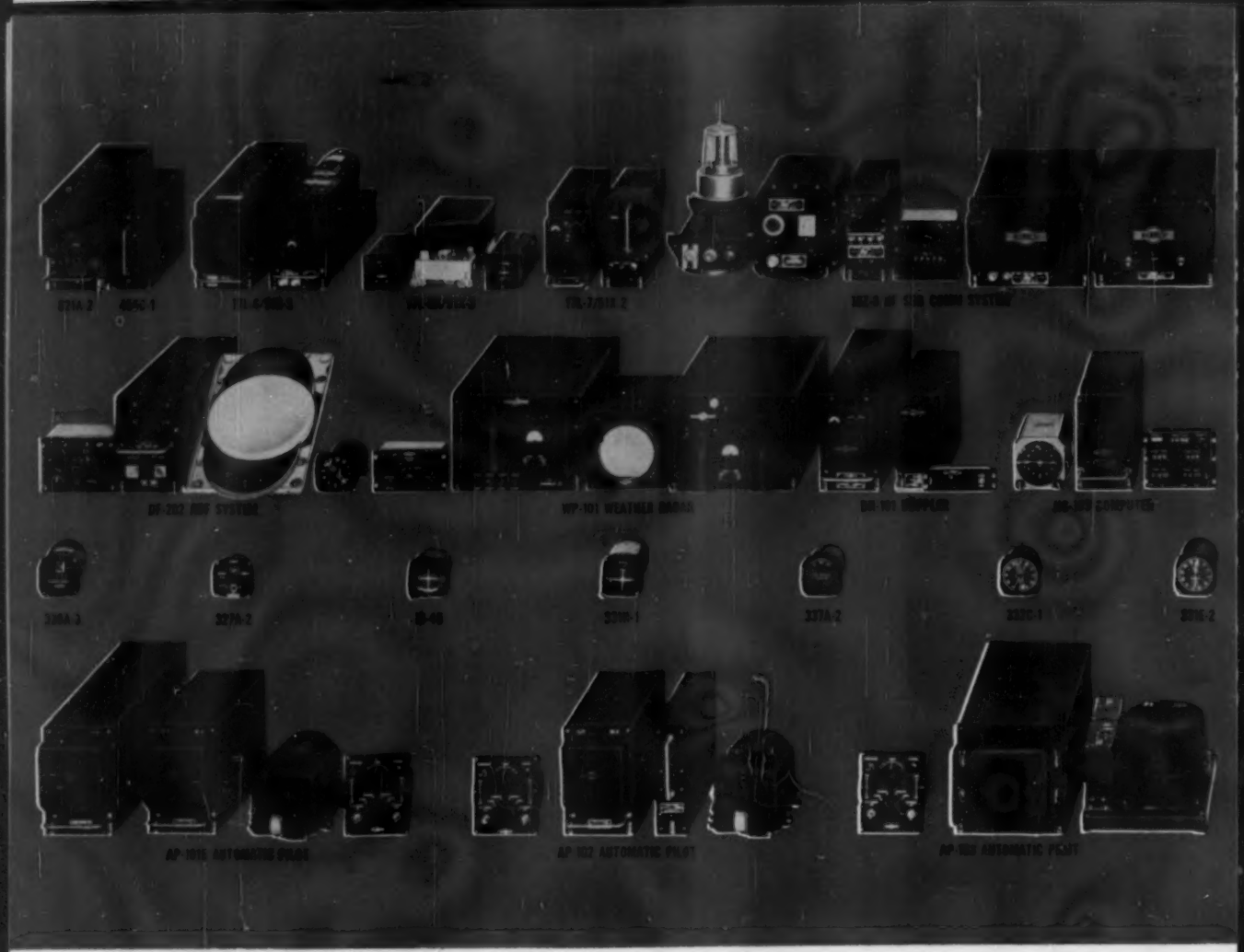
RMC
LINDSAY PRESSURE GAUGES



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COMMUNICATION

618A-2 TRANSPONDER — Autoloaded reader includes 20 AFC radar beacons. Rich, full-bodied aural tones transmit to radar tube of radarscope. Ceramic discrete transmitting tubes. 7/8 ATR case. Transposition wt. 26 lbs.

404C-1 RELCAL — Twelve resonant reed relay assemblies in each of two channels in 3/8 ATR short case. Switches on front panel keep coax selection. Selects 12 to 32 lbs.

491-C →/618-3 VHF COMM SYSTEM — Transmitter-receiver-control. 116/135.90 mc, 50 kc spacing, 720 channels. 116/135.90 mc, 50 kc spacing, 720 crystal controlled channels. 360 channels. 360 kc spacing, 100.0 to 135.9 mc. System wt. approximately 45 lbs.

17LBA/51X-3 VHF COMM SYSTEM — Lightweight 3 watt, 90 channel transmitter, 720 channel receiver and power supply. System controlled by 17L-4 panel. 17LBA-116.0-135.9, 51X-3 range 108.0-136.9. 100 kc spacement. System wt. 18.75 lbs.

17L-3/51X-3 VHF COMM SYSTEM — Airline standard 17L-3 provides 10 watts output on 720 channels between 116.0 and 135.90 mc. 51X-3 reception on 880 channels between 108.0 and 136.90 kc. 50 kc spacing. Crystal control. System wt. 27 lbs.

387 HF SSB COMM SYSTEM — Fully automatic SSB communication on 28,000 channels, 2-30 mc in 1 kc steps, 1 kc PEP. System includes transmitter, Receiver Amplifier, one or more Remote Controls. Antenna couplers available.

4137 HF SSB COMM SYSTEM — Fully automatic SSB communication on 28,000 channels, 2-30 mc in 1 kc steps. 400 watts PEP. System wt. approximately 50 lbs.

351-4 HF COMM SYSTEM — Self contained transmitter-receiver-control automatic tuning. Up to 20 crystal controlled channels, 2-18.5 mc. 400 watt output.

5103 HF COMM SYSTEM — Transceiver offers up to 144 crystal controlled channels in 2-23 mc range. 100 watt output. Has associated antenna coupler and power supply.

5404-1 AMPLIFIER AND ISOLATION AMPLIFIER — Provides interphone, isolation and speaker amplifier functions. Wt. 7 lbs.

5460-1 PASSENGER ADDRESS AMPLIFIER — Transistorized high fidelity amplifier. Inputs for pilot, observation and tape reproducer. Multiposition zone control. Wt. 9.6 lbs.

NAVIGATION

RF-202 ADF SYSTEM — Includes 51Y-3 Receiver, 4-blade dodec, dry dial numbers and tenths. Hand-held tube tuner to 11. Digital frequency presentation on Remote Control. Tunes 90 to 1800 kc in four bands. Flush or semi-flush mounted ceramic integral power supply. System wt. approximately 21 lbs.

WP-101 WEATHER RADAR — Pulse modulated operation in the C-band 5400 mc frequency range. Ranges: 20, 80, and 130 nmi's. Bright tube indicator offers daylight viewing without any hooded, oblique presentation.

RN-101 DOPPLER RADAR NAVIGATION SYSTEM — ENDOS 101 (redundant) used to enable operation from 6 to 25,000 ft. Flexible operation over several tens. Provides continuous indication of drift angle and ground speed. Dual system operates from single antenna. Equipment can be ground tested. Low power consumption. System wt. approx. 65 lbs.

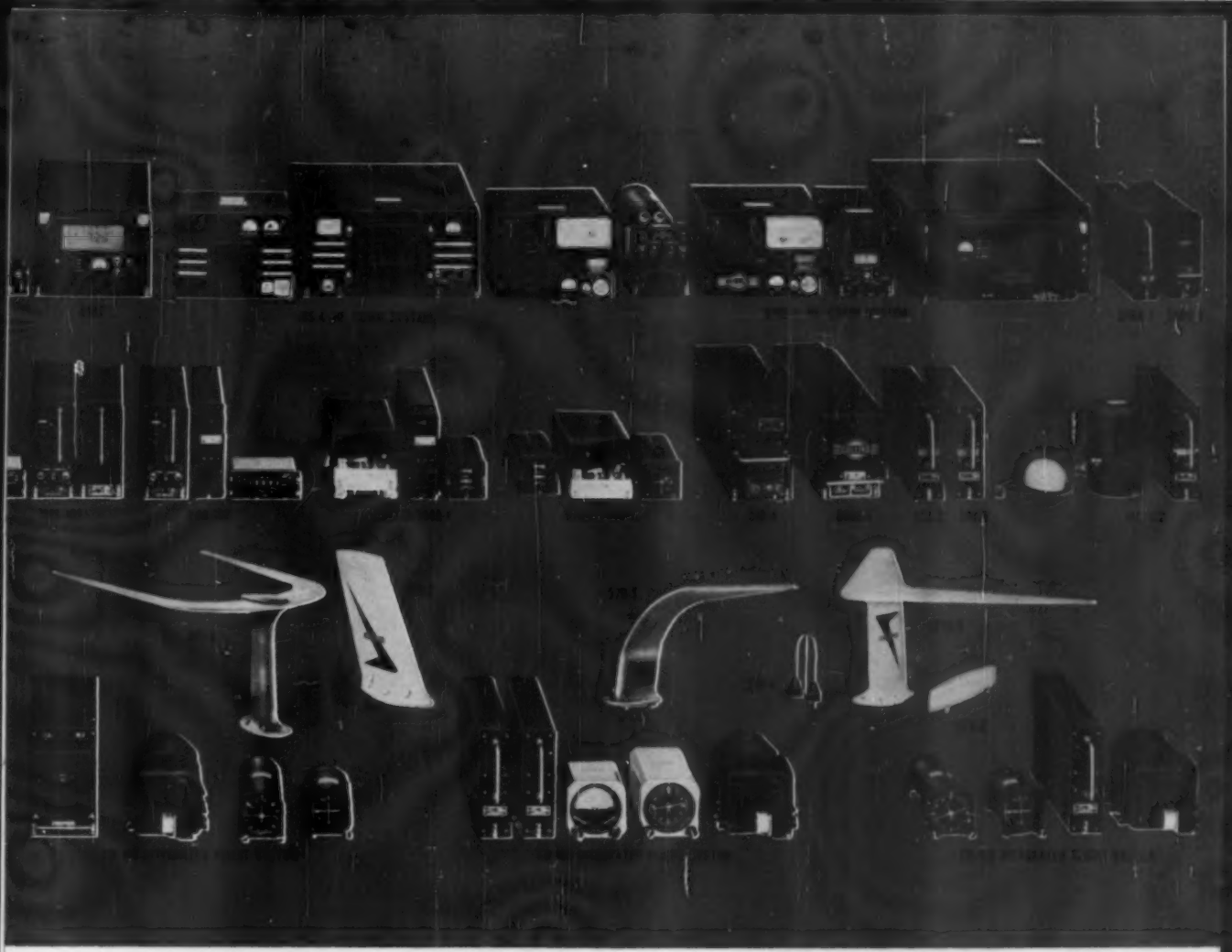
RC-103 DOPPLER NAVIGATION COMPUTER SYSTEM — Processes DRI-101 ground speed, drift angle and compass inputs and presents readings [illegible] and navigational information in a computer control panel. Supplies output data to course line deviation indicator, distance display and automatic pilot. System wt. 23 lbs.

VOR-101 VHF NAVIGATION SYSTEM — 51V-3/346A-1 combine to provide 160 channels with 50 kc spacing between 108.0 and 151.95 mc. Visual localizer, omnibearing, glide path to-from, OBI and RMI outputs in addition to voice reception. System wt. 24.5 lbs. Integral power supplies.

VOR-103 VHF NAVIGATION SYSTEM — 51X-3/346A-1 combine to provide same service as VOR-101 except an ILS receiver is available. 51X ATR short and 17L ATR short cases. System wt. 19.5 lbs. Integral power supplies.

51X-3/346A-2 VHF NAVIGATION SYSTEM — Ultrareliable dynamic compensation system with all services except ILS. System wt. 17.9 lbs.

51X-3/346D-1 NAVIGATION SYSTEM — Two panel mounted 3" cases provide VHF reception and full-right VOR/LOC indication, reciprocal bearing, to-from indications and VOR course selection. Associated power supply with integral clockmount. System wt. 29.50 lbs.



Ever since the early days of commercial aviation the prestige of Collins communication and navigation equipment has thrived, nourished by an energetic research and development program dedicated to the advancement of aviation electronics. The result is evident on these pages–the most complete line of high quality avionics equipment bearing one trademark. And even this group portrait is incomplete, lacking the scores of servos, remote control units, shock-mounts and test equipment associated with the major systems pictured. The Collins name is as important in military as it is in commercial aviation. In addition to the Collins communication and integrated electronics systems serving jet fighter and bomber squadrons throughout the world, Collins airline type equipment is widely used aboard military transports.

avionics

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INTELLIGENCE—Hallamore Microlock* provides the all-important link of intelligible communication between space vehicles and earth. Six Hallamore developed Microlock tracking stations monitor positions and receive intelligence from Vanguard and Explorer satellites...stand watch, with full capability, on U.S. Airforce and U.S. Army Lunar Probes. Microlock "locks" on fractional signals from tiny transmitters to bring in messages free of noise distortion. Hallamore developments in audio-visual telemetry, versatile automatic checkout systems, and guidance are speeding man's mastery of missilry and space technology. For systems capability, plug-in building blocks and C.C.T.V., write Hallamore Electronics Company, 8352 Brookhurst Avenue, Anaheim, California / TWX: AH 9079: a division of The Siegler Corporation.

*ORIGINALLY DEVELOPED BY JET PROPULSION LABORATORY, PASADENA, CALIF.

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A chance to own a share in America's future security.

Air Traffic Control — Experience with systems comprising radar search, computers, display and vehicle command. System synthesis, analysis and equipment development experience needed.

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Technical Writing — Maintenance manuals, instruction books, progress reports, technical proposals and presentations.

Correspondence regarding these positions should be addressed to:
Director, Scientific and Technical Personnel

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AVCO Crosley
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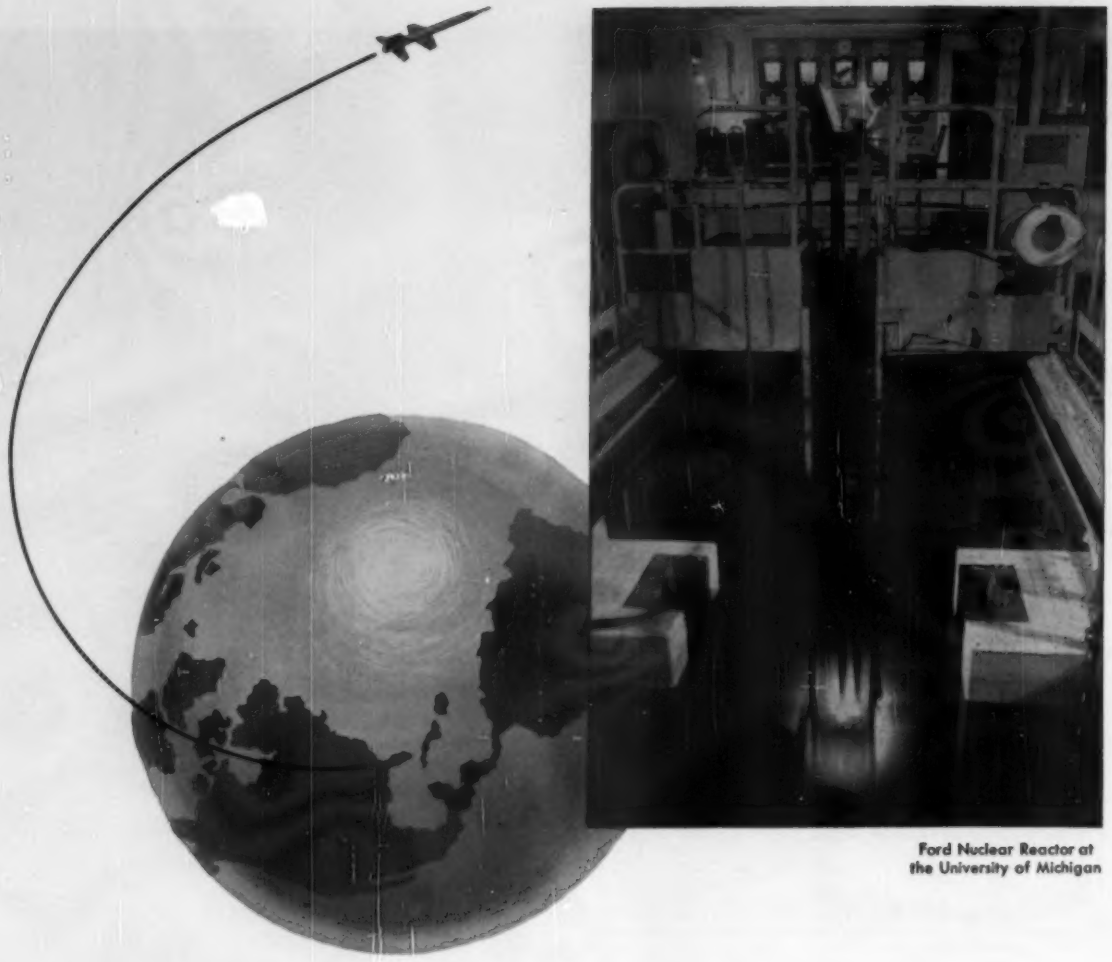

Ford Nuclear Reactor at
the University of Michigan

COMMUNICATION SYSTEMS

that resist nuclear radiation

Positive and reliable communications are the lifelines of new strategic weapons, hypersonic aircraft, satellites, and air defense. Resistance to nuclear radiation damage is an additional prerequisite for some of these advanced weapon systems.

The Bendix Systems Division, using the Ford Nuclear Reactor at the nearby University of Michigan, is developing radiation-resistant Mission and Traffic Control equipment. This work is being conducted by Bendix as a contractor to the Air Force. The objective is an M&TC subsystem providing extreme reliability under severe environmental conditions and over long operating periods.

Hypersonic aircraft and re-entry vehicles require that communications overcome the attenuation of surrounding ionized air. Bendix is carrying out propagation investigations and experimenting with designing special digital and voice communication systems. This work is under way at the Systems Division, Radio Division, and Pacific Division of the Bendix Aviation Corporation.

Positive communications also require resistance to jamming. Advanced research at the Bendix Systems Division has evolved techniques that combine jamming resistance and security of transmission.

Advanced communications know-how is being applied to additional programs for which the Systems Division has system management and engineering responsibility—such as the Navy EAGLE System and the Air Force AN/AMQ-15 Weather Reconnaissance System—and is applicable to many others.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

work in the fields of the future at NAA

DYNAMICS ENGINEERS

Immediate openings for vibration, flutter, and dynamic analysis engineers to work on the most advanced weapon systems —such as the B-70, the F-108, and the X-15, first manned space ship.

A background in AE, ME, or other applicable experience is necessary. Qualified vibration engineers will calculate and measure vibration levels for consulting on procedures to insure crew comfort and work out vibration environment problems on equipment of particular airframes. The flutter and dynamic analysis engineers will evaluate flutter characteristics, including servo systems, of particular airframes by analytical techniques and by the use of dynamic models, and conduct other studies relating to gust penetration, landing, and taxi conditions.

For more information please write to: Mr. A. D. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

tons and carrying 12 persons now used to transport the test rigs in Idaho from the test area two miles down the track to the shielded maintenance shop. This locomotive probably would be used to transport a nuclear bomber after a flight from the end of the runway into a large concrete maintenance hangar. The aircraft would be run up on a low flat car on tracks and then pushed by the locomotive.

Two major remote handling items needed for the actual operation of a nuclear aircraft have been designed but not constructed. They are:

- **Large concrete hangar** with shielded areas for the removal and storage of highly radioactive items and normal airframe maintenance.
- **Self-propelled, shielded vehicle** with manipulator arms to perform many of the required connects and disconnects of the reactor and aftercooling equipment just after landing. This vehicle would be very heavy because it would carry 75,000 lb. of lead and steel shielding against gamma radiation. Neutron flux becomes extremely small as soon as the reactor is shut down.

Long Utilization

Principal reason why long utilization comparable to commercial aircraft and much better than military experience in the past is being predicted for the subsonic nuclear aircraft is that flights will last approximately one week, and that only about 15 a year would have to be made to reach this utilization figure.

Past experience has also shown that systems on the nuclear aircraft probably will be more reliable than those on conventional aircraft because they will operate under steady state conditions for much longer periods. Failure rate of complex mechanisms has been shown to be dependent on the number of operation cycles performed rather than the number of hours of steady state operation.

Most extensive facility for the experimental study of the effects of nuclear radiation on aircraft materials and assemblies is being operated for the Air Force by Lockheed in the North Georgia mountains. This facility allows the simultaneous irradiation of six railroad-car loads of material. A large reactor has been placed on an elevator so that it may be raised from its normal position at the bottom of a shielded pit filled with water to irradiate the test specimens. After they have been exposed for the proper length of time the reactor is lowered and the railroad cars are automatically released so that they will roll away to a safe location where they can cool off and then be transported by normal means to an inspection laboratory 2.5 mi. distant.

Primary conclusion of the materials

work in the fields of the future at NAA

COUNTER-MEASURES ENGINEERS

Work on America's most advanced weapon systems.

At North American Aviation, such top-level projects as the B-70 and F-108 weapon systems have created unique careers with a tremendous engineering potential.

We have immediate openings for specialists and systems engineers in the field of electromagnetic and infrared countermeasures. Specialized areas include high power traveling wave tube analysis, receiver techniques, system logic, infrared systems design, and antenna and radome development. Experienced engineers are needed to establish requirements for countermeasures systems and to evaluate new components and techniques and their application to advanced systems.

Minimum requirements are actual experience in countermeasures plus B.S. degree in EE or Physics.

For more information please write to: Mr. A. D. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

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FOR EVERY TYPE OF PLANE ...EVERY KIND OF OPERATION!

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A simplified list is shown for various operations, as there are five grades of Mobilgas Aircraft, five grades of Mobiloil Aero and various grades of other products from which the proper selection can be made.

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work which has been done to date is that it will be possible to build a subsonic nuclear aircraft from existing materials if they are judiciously used. Organic materials are most affected by radiation because they are damaged by both neutrons and gamma rays. Both of these types of radiation, which are the major ones coming from a fission reactor, cause ionization and organic molecules, which by their nature try to rearrange their bonds to include the new fragments and usually form a new molecule with new chemical properties.

Inorganic solids are much more stable than the organic materials. Damage to the inorganic substances is due primarily to neutron action alone. This damage is in the basic crystalline structure, with the neutrons knocking atoms from their place in the lattice. This causes changes in electrical, structural and thermal properties.

Two basic factors work in favor of using inorganic materials in high radiation fluxes and at high temperatures. First, the damage is proportional to radiation dosage only up to a certain point. After that, atoms begin to get knocked back into their proper spot. There is a maximum disorganization that can occur, depending on the material. Second, high temperature has the effect of annealing or curing the radiation damage because as the temperature is increased, the atomic vibration and migration is increased and atoms are allowed to regain their normal position.

(This is the second of two articles dealing with the technical feasibility of a subsonic nuclear aircraft. First article appeared in Aviation Week *on Mar. 30, p. 86.)*

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Beech Aircraft Corp., Wichita, Kans., facilities in support of missile tank test program, (PR BI-9-F-9112), $998,300.

Phillips Electronics, Inc., Mt. Vernon, N. Y., 1,408 ea., controls, C-1514A/ARN-6f for use on T-33 aircraft, (PD MD-9-5826-37014), $109,824.

Lycoming Division, Avco Corp., Stratford, Conn., additional funds covering the maintenance and service of 31 ea. Lycoming ST, YT and T53-L-3 turboprop engines for the Army YAO-1 aircraft program, (MIPR R59-3-TC-RE), $539,000.

Bell Helicopter Corp., Ft. Worth, Tex., HU-1A helicopters, spare parts, ground support equipment, data and handbooks, (MIPR R59-902-TCSMC-A), $20,817,626.

Engineering and Optical Division, Perkin-Elmer Corp., Norwalk, Conn., photographic equipment, film, services and supplies, (PR 91143-A), $255,000.

The Scientific Oil Compounding Co., Chicago, Ill., 7,000 yds. non-toxic fungicidal cotton textile materials, IFB 33-600-58-89 (PR PM-9-RD-6090), $30,730.

Westinghouse Electric Corp., Dayton, Ohio, 74 ea., power supplies, P/N 904J027-2, including spare parts, test equipment, maintenance tools, and data for C-130B aircraft, (PR EA-9-03C-4402), $101,924.

Fletcher Smith Studios, Inc., New York, production of 1 ea. 35mm. black and white sound motion picture entitled "ASB-4 Bomb Navigation System Data Flow," parts C and D, project 19258, REP 32-600-59-5024 (PR EM-9-MP-6149), $47,525.

Pioneer-Central Division, Bendix Aviation Corp., Davenport, Iowa, 170 ea., amplifiers, electronic control, type MF-1, Aerno 61-803, for use on KC-135A aircraft, (PR EA-9-05G-4499), $89,661.

Red Bank Division, Bendix Aviation Corp., Eatontown, N. J., 174 ea., motor generators, P/N 12142-1-A, FSN 4213-6125-483-9750, to support T-33 aircraft, (PR's SA-9-03C-8225 and SA-8-03C-5762 and amendment No. 1), $52,676.

Marquardt Aircraft Co., Ogden, Utah, services to provide for the start-up and phase-in of the Little Mountain Test Facility, (PR EP-9-2840-4522), $406,478.

Stratford Electronics Division, Bruno-New York Industries Corp., New York, 353 ea., relay assemblies, RE-141/ARW, spare parts, test equipment and data for support of modification programs for QF-80 and QB-47 drones, (PRs MD-8-16A-20743 and amendment No. 1; MD-8-16A-20759 and amendment No. 1; MD-9-16A-35117 and amendment No. 1; SM-9-16A-2015; SM-8-16A-2074; MD-9-16A-35214 and amendment No. 1), $58,165.

Texas Instruments, Inc., Dallas, Tex., procurement of services, materials for additional work to carry out manufacturing methods production refinement of high voltage silicon rectifiers and clipper diodes, (PR PB-8-MMP-6163-1), $115,293.

Hamilton Standard Division, United Aircraft Corp., Windsor Locks, Conn., propeller control assemblies and feather switch for C-130 aircraft, (PR's PE-9-03A-1132 and amendment No. 1 and EA-9-03A-4838), $134,815.

Propeller Division, Curtiss-Wright Corp., Caldwell, N. J., product improvement for CT7SS-B100 series propellers, (PR's EA-9-03A-4567 and 4568 and MIPR R59-121-20-NOas), $1,255,314.

The world's first rocket space ship, designed to carry man into the ionosphere, is painted with a Rinshed-Mason heat-resistant black enamel. This super tough finish was made expressly for North American Aviation, Los Angeles Division, manufacturers of the X-15. Aerodynamic temperature build-up to +1200°F. is expected as this "black phantom" reaches the re-entry phase into the earth's atmosphere at hypersonic speeds. The R-M enamel is expected to withstand these extreme temperatures and to dispel the absorbed heat at the fastest possible rate.

Your inquiry cordially invited.

R-M

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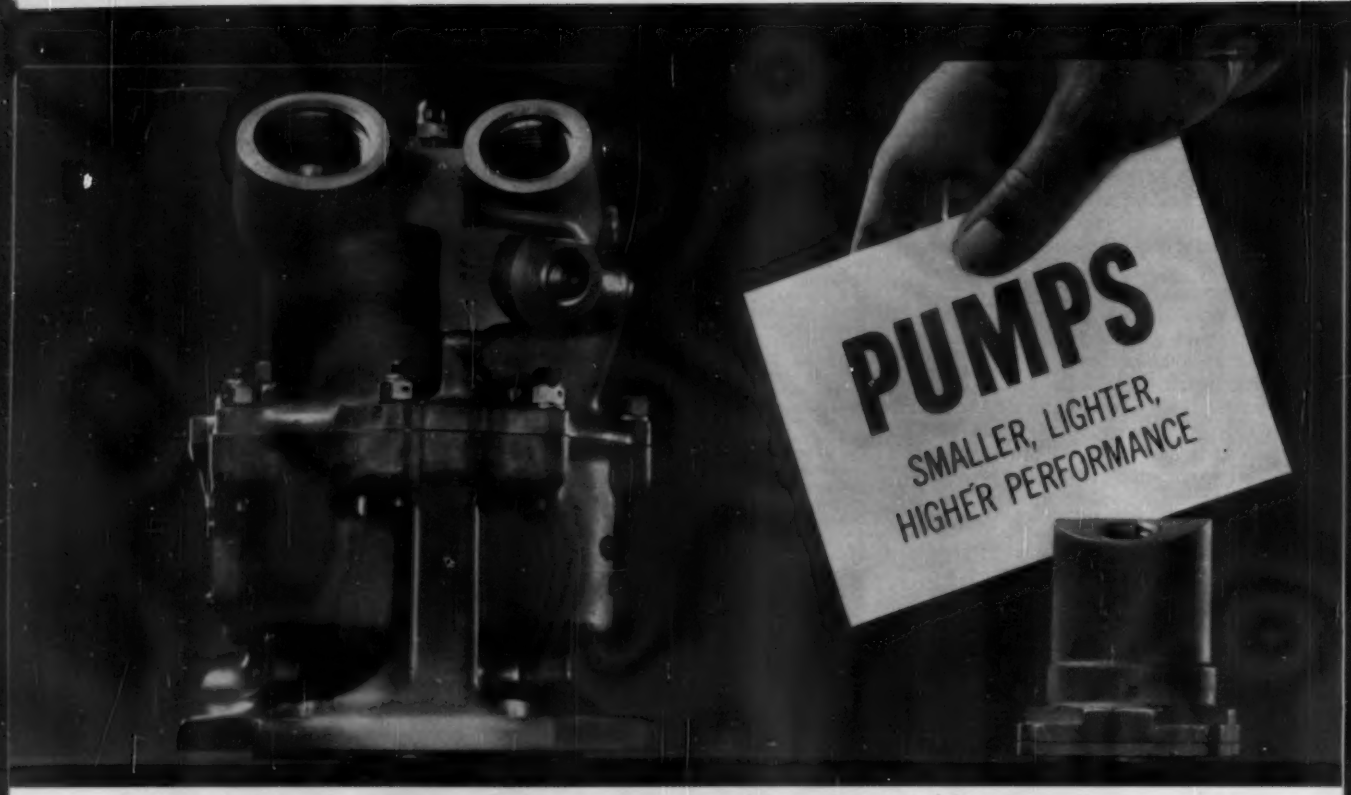
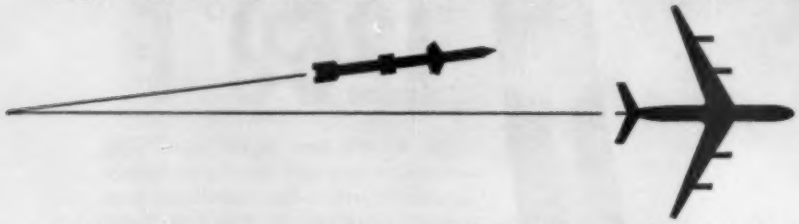


AIRCRAFT AND MISSILE HYDRAULIC PUMPS

A new family of lightweight hydraulic pumps having fixed or variable displacement in sizes from 1 to 30 GPM operating at speeds up to 12,000 RPM and higher. This design has many important features, including fewer parts and inherent capability to perform at higher speeds and elevated operating temperatures. If you will send us your requirements we will be happy to submit recommendations for your installation without obligation.



HOW BENDIX

Bendix Hamilton was established in 1951 to develop and manufacture high precision fuel systems and hydraulic components for the aircraft industry. Today expanded facilities and a broader product line permit us to serve the missile industry as well.

Major products—aircraft and missile hydraulic pumps; hydraulic components and sub-systems; engine fuel pumps and fuel system components; precision bellows and bellows assemblies; thermostats and related sub-assemblies; and subcontract manufacturing and brazing.

PRECISION BELLOWS, SUB-ASSEMBLY WORK →

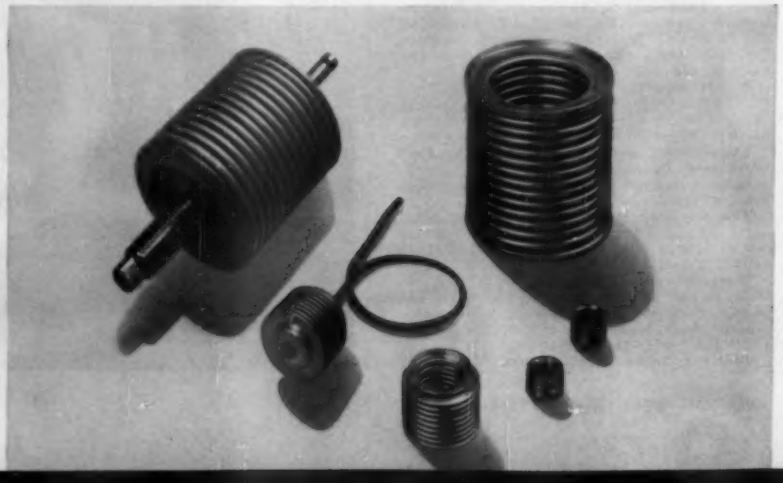
Bellows and bellows assemblies for aircraft and missiles, ordnance and other precision instrumentation tailored to your needs. Originally developed to meet the exacting requirements of aircraft and missile components bearing the Bendix name. Hydraulic forming together with precision process laboratory control of materials selected—brass, Phosphor bronze, beryllium copper, stainless steel, Monel, etc.—assure maximum resiliency and long service life.

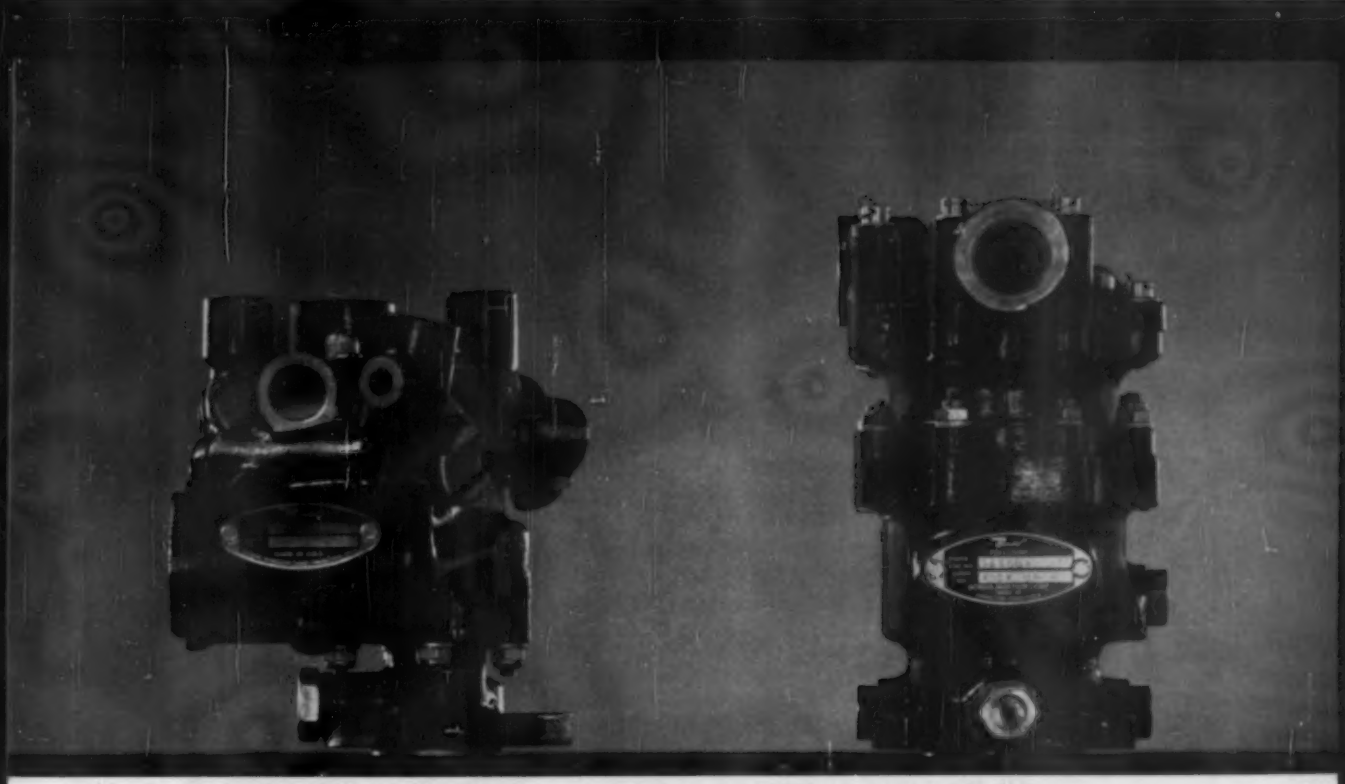
ALUMINUM DIP BRAZING

Molten flux dip brazing techniques offer freedom of design. Wrought, stamped and pre-machined aluminum alloy parts may be joined into complicated forms to provide lightweight pressure-tight assemblies to replace castings with complicated coring and machining.

FURNACE BRAZING →

Dry hydrogen brazing of high-strength, high-temperature alloys using controlled atmosphere dry hydrogen furnaces makes possible the fabrication of

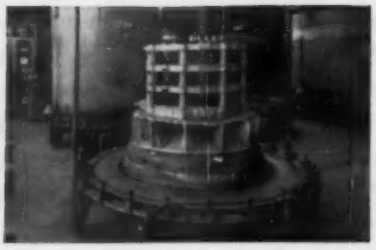




HYDROCARBON AND CHEMICAL FUEL PUMPS

A new family of gear pumps for turbine engines and other applications for hydrocarbon fuels in sizes from 150 pounds per hour to 3,000 pounds per hour at discharge pressures up to 1,000 PSI. Piston fuel pumps are available for higher discharge pressures where required. A special mono-propellant pump having capacity from ½ to 4½ GPM at 3,600 RPM is also available for Ethylene Oxide, Hydrazine, Normal Propyl Nitrate, and other similar fuels.

HAMILTON CAN HELP YOU



complex assemblies such as turbine burner rings, manifolds, etc., up to 42″ in diameter.

SUB-CONTRACT MANUFACTURING

Available sub-contract manufacturing facilities embrace all phases of production engineering and precision machining, high-temperature brazing, assembly and test of customer-designed components and systems. Current aircraft engine and missile production programs include fuel and hydraulic components as well as surface control actuators.

SERVICE AND OVERHAUL

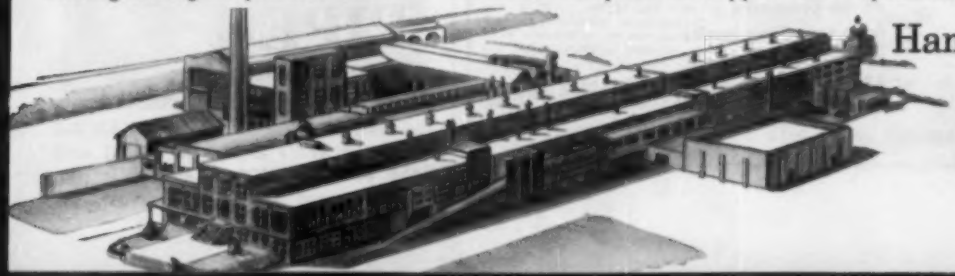
Complete field service and overhaul facilities are provided and offered to all customers in support of all original equipment programs—another reason why it will pay you to do business with Bendix Hamilton.

FACILITIES

Bendix Hamilton engineering, manufacturing and test facilities are diversified and complete to support all product programs. Physical plant space of 232,000 square feet includes air conditioned, humidity-controlled, dust-free areas for assembly and test of precision products.

Lapping operations hold flat surfaces within one light band when checked with an optical flat. Grinding and honing departments continuously maintain tolerances as low as five millionths of an inch on production work.

The specialized engineering and production test facilities offered to any Bendix Hamilton customer are complete to develop and produce equipment to the most exacting requirements of the aircraft and missile industries. They assure a quality end item manufactured and tested to your specifications.



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Stands to reason . . . here's an airplane so far advanced in features and performance, yet so sensibly priced, that it's sweeping the market. Public enthusiasm for the sleek, beautiful Comanche is far ahead of the most optimistic expectations! ✈ ✈ ✈ By every standard of comparison, sensible, clear-thinking analysis shows the Comanche has far and away the best combination of features. Nothing compares with it, on a dollar-for-dollar basis. In the economical 180 horsepower Comanche ($14,995) you find performance equal to or better than any all-metal four-place plane in its class and you get it with far less fuel consumption, much lower all-around operating costs. In the fabulous 250 horsepower Comanche ($18,995) you climb 1400 feet per minute . . . cruise an *honest* three miles a minute. And you can equip your Comanche 250 with full instrumentation, multiple radio, automatic flight system, heated pitot, rotating beacon—the works—for less than the *bare* price of any other aircraft of similar performance. ✈ ✈ ✈ But forget price. In the Comanche—180 or 250—you get a better, more useful, more comfortable airplane . . . biggest cabin, biggest baggage space, biggest useful load, by far! And you get a modern-as-a-jet airplane with the commanding eye appeal that makes you and your Comanche the center of attraction wherever you fly.

Get the full story on the Comanche from your Piper dealer or write for new 1959 Comanche brochure, Dept. W-4.

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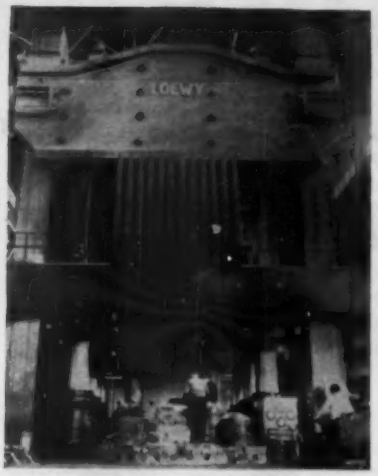

CLOSED-DIE forging press, rated at 50,000-ton capacity, will shape beryllium parts.

Beryllium Forging Process Developed

New York—Improved ductility properties of beryllium resulting from a closed-die forging process are expected to enhance the metal's value as a heat sink and structural material for space vehicles.

Forging process, developed at the Wyman-Gordon Co.'s USAF plant at North Grafton, Mass., produces large structural parts which require a minimum of machining. Beryllium, known for its high modulus of elasticity, high strength to weight ratio and heat sink capacity, has always been considered too brittle for large structural parts. Wyman-Gordon reports, however, that its forgings have ductility and isotrophy of the order of the strong aluminum alloys.

First missile component produced by means of the forging process was a conic missile section.

Development of a successful forging process, in addition to increasing the metal's ductility, permits volume production of beryllium parts. Prior pro-

BERYLLIUM missile forging is removed from 18,000-ton press at USAF facility.

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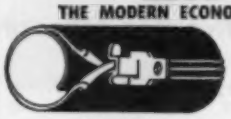

74 TYPE

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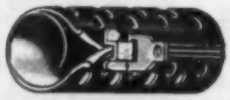

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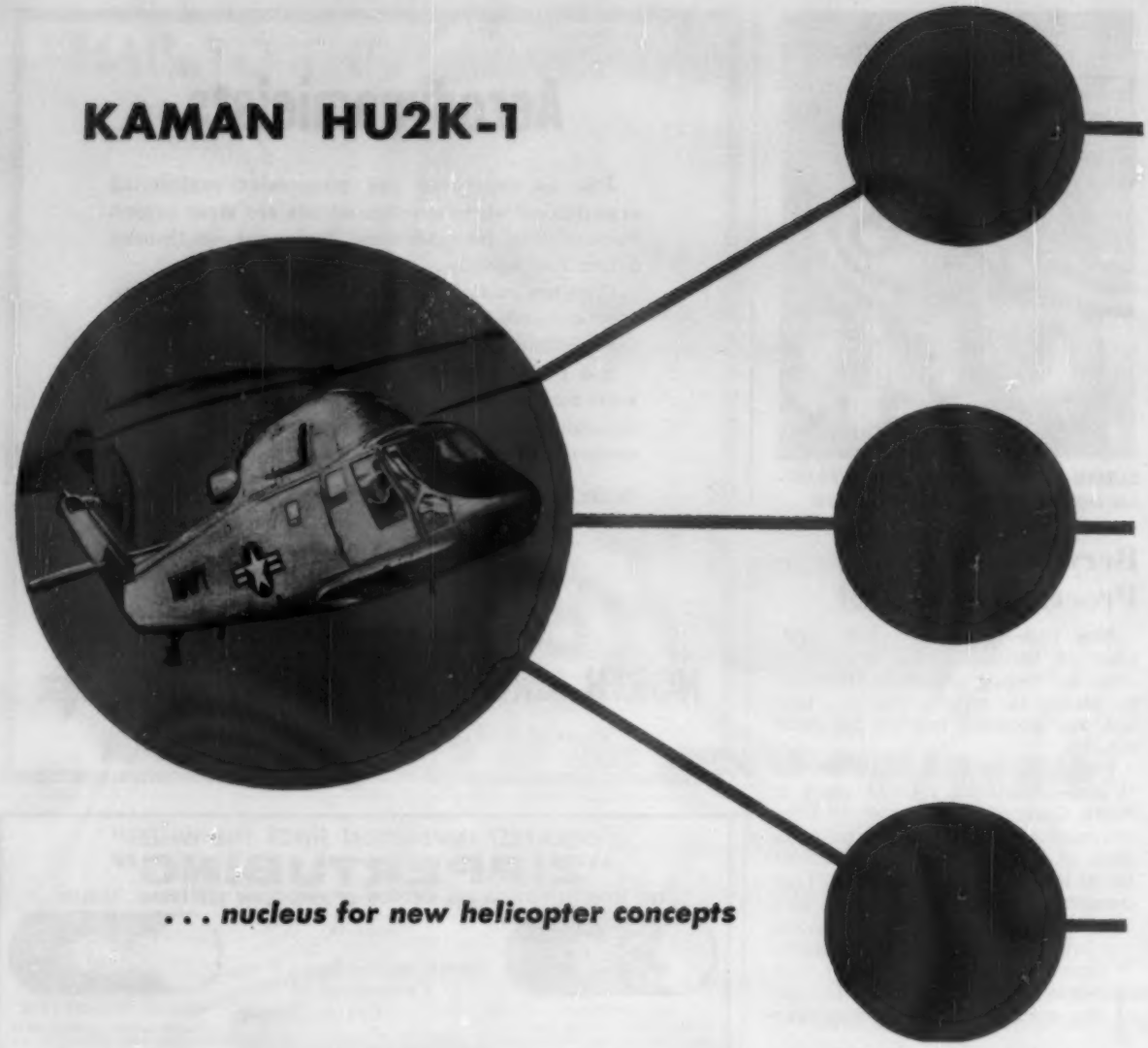

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duction methods required machining rough blocks under little or no pressure and subjecting the finished parts to long periods of heat treating. Forgings, which are completed in minutes, require a minimum of machining.

The beryllium forging process was developed at Wyman-Gordon as part of a company-financed research project. Details of the closed-die process were not disclosed. Wyman-Gordon is investigating the possibility of patents.

The company did reveal that nuclear-grade beryllium powder obtained from the Beryllium Corp. was forged in an 18,000-ton forging press. Oxidation is prevented by either a protective atmosphere or vacuum method.

WHAT'S NEW

Reports Available:

The following reports were sponsored by the Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

A Proposed Mechanism for the Strengthening of Sap-Type Alloys—by G. S. Ansell, Naval Research Laboratory, October, 1958. $.50; 4 pages (PB 151047).

The Preparation of Tungsten Carbide-Uranium Compacts of High Density and High Hardness—by P. A. Kulin and N. S. Dallas, Watertown Arsenal Laboratory, U. S. Army, December, 1953. $1.25; 36 pages. (PB 131751).

Investigation of a Method for the Measurement of Subsonic Oscillatory Aerodynamic Influence Coefficients—by H. N. Abramson and P. A. Beckman, Jr., Southwest Research Institute for Wright Air Development Center, U. S. Air Force, December, 1957. $2.00; 76 pages. (PB 131819).

Drag Due to Lift of a Not-So-Slender Configuration—by H. K. Cheng, Cornell Aeronautical Laboratory, Inc. for Wright Air Development Center, U. S. Air Force, September, 1957. $1.25; 46 pages. (PB 131702).

Incompressible Friction Factor, Transition and Hydrodynamic Entrance Length Studies of Ducts With Triangular and Rectangular Cross-Sections—E. R. G. Eckert and T. F. Irvine, Jr., University of Minnesota for Wright Air Development Center, USAF, April, 1957, $1.25; 38 pages. (PB 131771).

Chemical Resistance and Thermal Stability of Fluorocarbon Elastomer—A. Wilson, C. B. Griffis, and J. C. Montermoso, U. S. Army, December, 1957. $.75; 23 pages. (PB 131942).

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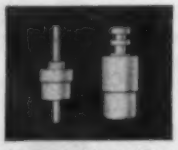

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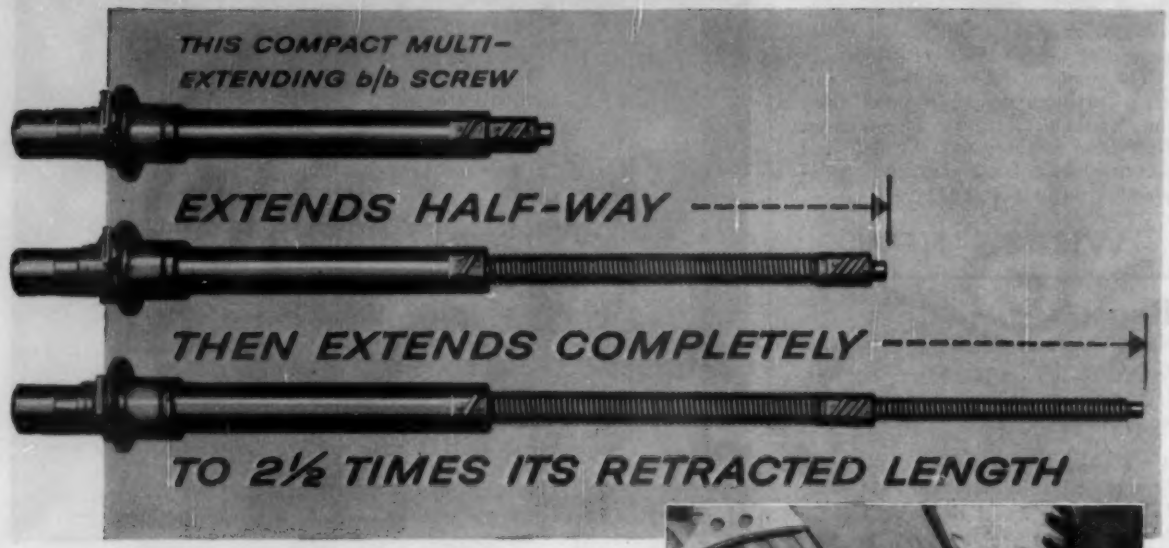

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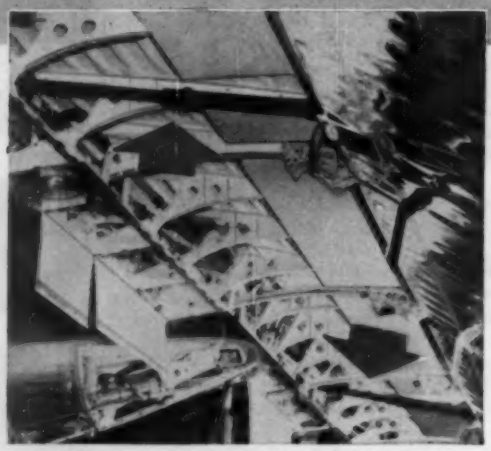

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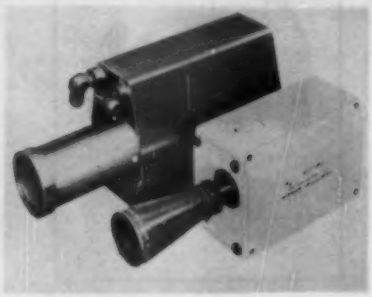

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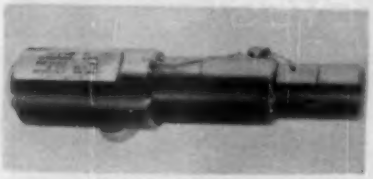

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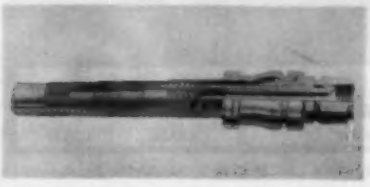

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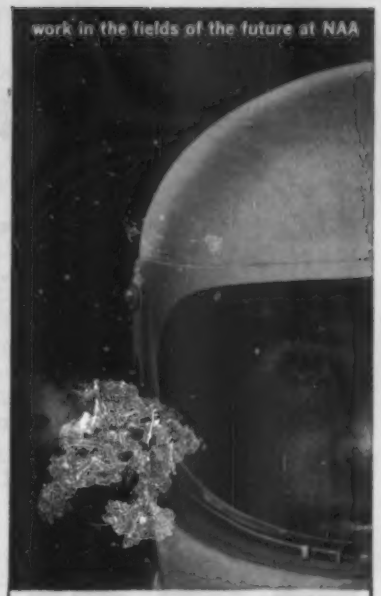

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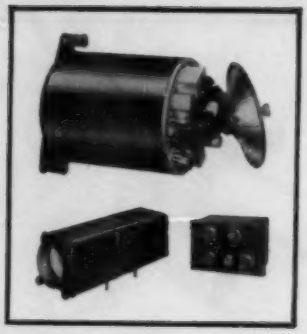

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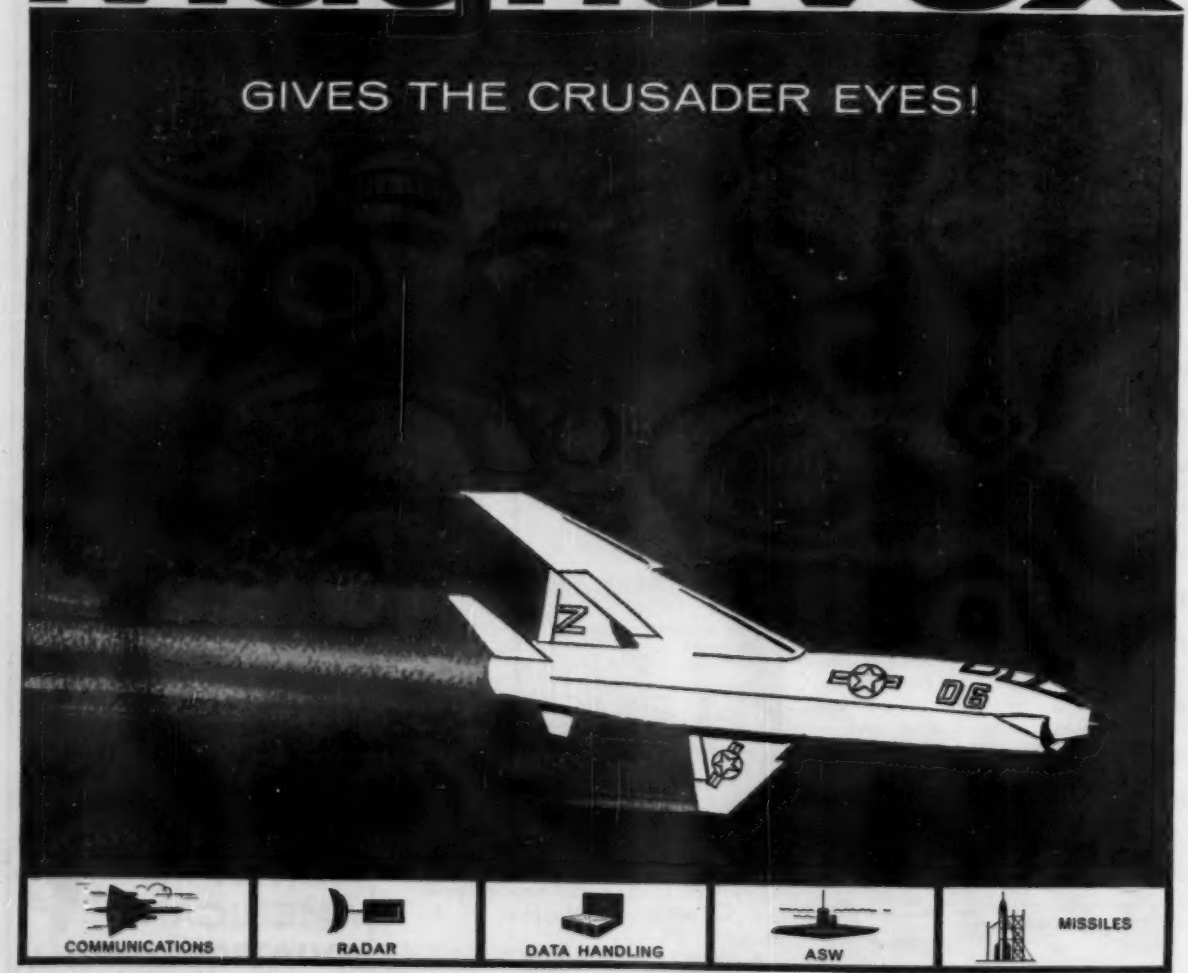

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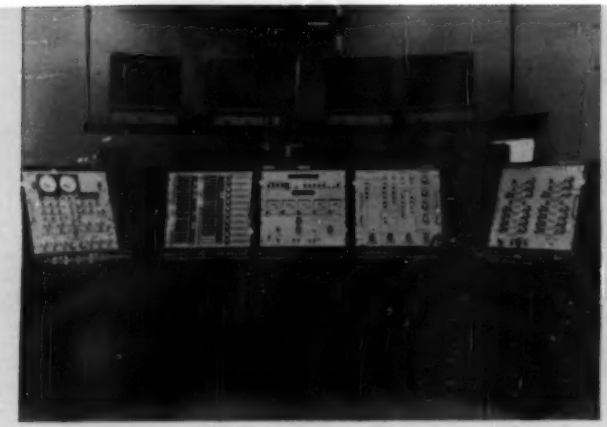
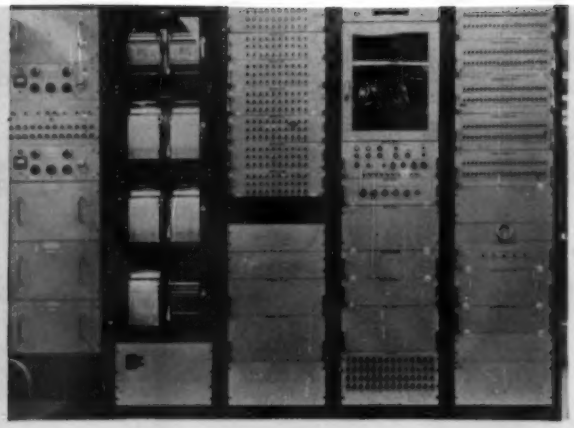
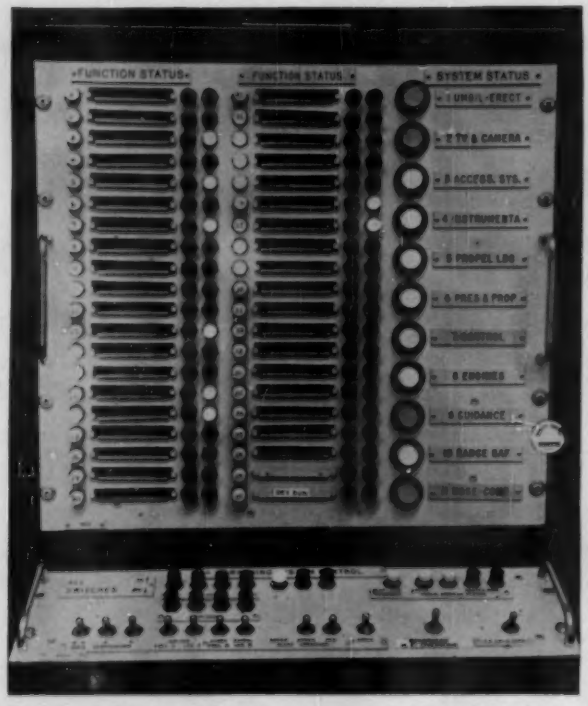
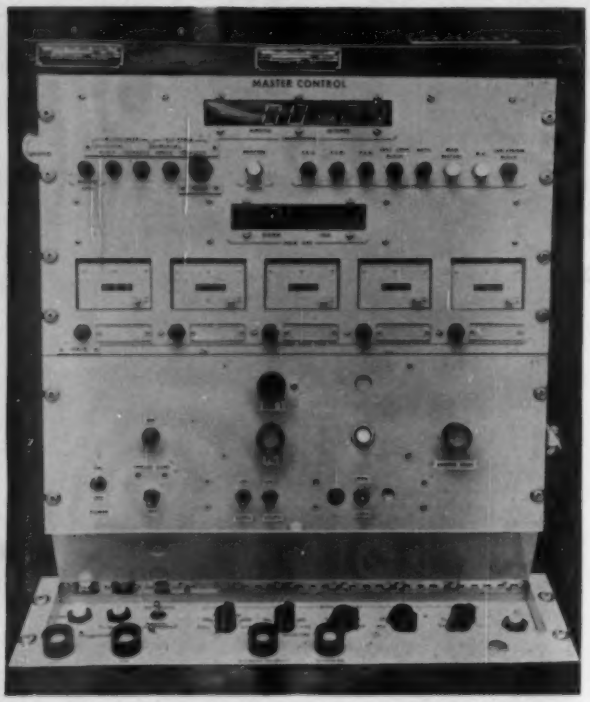




Concrete blockhouse at The Martin Co.'s Denver Division test facility for Titan intercontinental ballistic missile contains master operations control console (left); panel at left is for water system control, one at extreme right is erector panel. At right is countdown sequence unit.

Operations Console Controls 200 Titan Functions





Closeup of function and system status panel (above, left) shows varied stations, ranging from "lox tank kill" to "siren." Lights indicate status of the function. At right, the countdown time readout is shown in top window in red. Second window indicates malfunction.

Master operations control operator (below, left) patches in a countdown on the master sequencer program board. About 200 functions can be checked. At right, console operator checks the erector panel. Operator can hear all conversations but must press button to talk.

Chance Vought Aims at Diversification

By Craig Lewis

Dallas—Spurred by recent contract cancellations and backed by high current sales levels, Chance Vought Aircraft, Inc., is working hard to reshape itself as a more diversified company with a broader market base.

Over the past year or so, Chance Vought has taken a number of steps in management and technical areas which point toward diversification and new markets. These efforts were given new urgency when the Navy canceled the F8U-3 and Regulus II programs in December, but Chance Vought had been on the move long before these projects were lost.

Like other aircraft manufacturers, Chance Vought is faced with a radically changing military market in which highly complex systems are bought in small numbers and where generations of large production runs for a variety of military aircraft are rapidly becoming history.

Along with this general situation, Chance Vought has the added problem of being a company with a single traditional customer—the Navy. Thus the company is working to broaden its activities within a new military market and to move into new markets.

Despite the twin blows of the December contract cancellation, Chance Vought had the best year in its history in 1958. Sales were $333,192,432, up sharply from the $237,292,770 figure for 1957, and earnings after taxes rose from $6,152,383 in 1957 to $8,957,626 last year. The company distributed $2,157,146 in dividends in 1958 and wound up the year with net working capital of $37,881,514. Earnings amounted to $7.55 per share.

Chance Vought exchanged $3,676,000 worth of convertible debentures for stock in 1958, leaving debentures totaling $8,824,000 at year end. During the year the company expanded its line of bank credit to $34 million, with borrowings totaling $19 million at the end of December.

With this record for 1958, and with business continuing at a high level in 1959, Chance Vought is in good financial shape to support its diversification effort.

The only area where the annual report shows a decrease from the previous year is in unfilled orders. Backlog is down sharply from $670 million at the end of 1957 to $370 million at the end of last year, and that is where a good part of the damage from the cancellations lies. Orders canceled were worth about $110 million.

CHANCE VOUGHT Aircraft's engine runup ramp has positions for 23 aircraft which can be worked on simultaneously; each position has compressed air outlets for engine starting. Three air receivers are located next to hangar at top left. Dura Stack sound suppressor is at top center, with F8U-2 Crusader parked nearby. Aircraft on the line are F8U-1s, with a single F8U-1P. Note jet blast deflectors.

Both of the programs canceled would have added to production volume this year but, more important, they were advanced weapon systems with production lives which were likely to stretch beyond the Crusader fighter series now in production. Employment dropped from an average level of 16,600 during 1958 to 12,700 at year end, with the layoffs bunched in the last two weeks of December following the cancellations.

Several hundred more workers have been released since Jan. 1, and the impact has been spread through production, engineering and test range personnel, although the bulk of the layoffs were from the production force.

The F8U-3 was in the early production stages and would have been building up this year, adding to current production work and providing a product that would be produced after the current Crusaders were phased out. In contrast, the Regulus II was much closer to maturity and would have proceeded at about the level it had reached.

Another item missing from the production line this year is the Regulus I. This program was phased out as expected in December after Chance Vought had built 514 of the missiles. This leaves 1959 business volume almost totally dependent on the Crusader series fighters—the F8U-1, F8U-1P, F8U-2 day fighters and photoplane, and the F8U-2N, an advanced version with limited all-weather capability.

With the Crusader production now scheduled, Chance Vought expects to have the second best year in its history. That means sales somewhere between last year's $333 million and the $237 million grossed in 1957. Crusader production is expected to last through 1964, although the production rate will be diminishing as the fighter series moves toward obsolescence.

Chance Vought is working on pilot capsule and human factors aspects of the Dyna-Soar program as a member of the Boeing Airplane Co. team, and this could furnish future business if the Air Force picks the Boeing team for the job. The company also has a subcontract to build tail sections for the North American B-70. This work is largely

The PLANE

America's newest production bomber, the Convair B58 Hustler. This delta-wing jet employs an area-ruled fuselage for supersonic regime efficiency, and has reportedly been flown in excess of Mach 2 at 50,000 feet. Engines are four J 79's, in pods below the wings.

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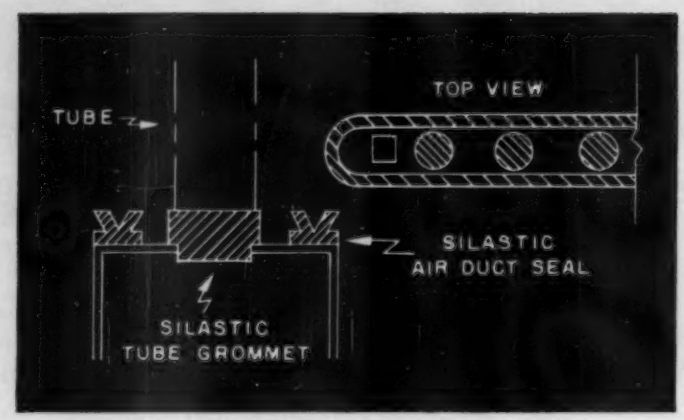

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in engineering now, but tooling and production will start to phase in late in the year.

Chance Vought President Fred O. Detweiler told AVIATION WEEK his company reacted to the Regulus II and F8U-3 cancelaltions in much the same fashion that it met similar situations in the past. "We put a lot of people on the road looking for new business," he said, just as Chance Vought did in 1954 when the A2U-1 was canceled. At that time the company searched for subcontract work and engineering studies. Research and development work was increased and the engineering organization was beefed up.

After the 1954 cancellation, Chance Vought started working on its diversification program, and the cancellations late in 1958 added new urgency to this program and motivated faster decisions in business planning. Detweiler said they "took two or three years of comfort factor out of our future planning."

Shaping an Image

Chance Vought has been a separate corporation since it was spun off from United Aircraft in 1954, and the company has been slowly shaping a new, independent image for itself since then. This has amounted to a step by step orientation "to our view of the future," Detweiler said, and in viewing the future it seemed a good idea to break out of the special role as a supplier of Navy carrier aircraft and to diversify, especially in the changing military market of the past few years.

In 1955, operations were broken down under four vice presidents—engineering, production, controller, and sales and service. Then in 1958, Clifford E. Burt was shifted from the job of vice president and controller to the new job of vice president-finance. Later last year the directors approved a new management organization in which Vice President-Engineering Raymond C. Blaylock became vice president and general manager. Vice President-Production Gifford K. Johnson became vice president for business planning, and Sales and Service Vice President W. Paul Thayer became vice president in charge of the Washington office and of foreign sales.

With these changes, Chance Vought's top management is freed from everyday operations to concentrate on broad corporate matters and on the push for new business and new markets.

Part of the search for new business lies in the increasingly competitive subcontracting field. In the past Chance Vought has never had more than 10% of its sales in subcontracting and Detweiler doesn't expect it ever to go over that level. He said that subcontracting

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Most important requirement for these positions is *versatility* — that blending of education and experience which equips engineers to think in terms of hardware under field test conditions. An engineering degree and missile test experience are most desirable, but a sound background in related work can furnish the necessary qualifications. Specific requirements are in **ELECTRONICS** (R.F. communications, instrumentation, missile control and guidance systems) **MECHANICAL ENGINEERING** (pneumatics, hydraulics, propellant handling and loading, mechanical ground support equipment), and **CIVIL ENGINEERING** (establishment of design criteria on missile facilities). There are also outstanding opportunities for **ENGINEERS AND SCIENTISTS** in many other areas and at all levels for a variety of space programs under way at Convair-Astronautics' San Diego headquarters. Our engineering representatives will be conducting **INTERVIEWS** in these and other cities soon:

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will never be a major portion of sales.

Detweiler points out, however, that the definition of subcontracting gets hazy when such things as systems work, electronics work and parts of test programs are involved. He definitely does not include team participation, such as Chance Vought's Dyna-Soar work, in the 10% top estimate for subcontracting.

While management organization has been shifting, some changes have taken place in the company's technical organization which mark a trend toward product line groupings. An electronics department has been established to handle electronic work for Chance Vought's current programs and to furnish support for diversification into new fields. An anti-submarine warfare group has been set up to explore that vital problem area. A range systems division was established to exploit Regulus experience and bid for work in the burgeoning market stemming from such projects as the Pacific Missile Range and a new Army range at Ft. Huachucha. While these activities and others develop prospects for new business, they also furnish work for valuable technical personnel Chance Vought wants to keep.

With this orientation toward product line groupings, any of these integrated groups could be lifted out of the present organization here and established as a separate operating division any time business should warrant such a move.

Broadened Market Sought

Chance Vought has bid in various Navy, Air Force and Army competitions in an effort to broaden its military market. Last year the company took the somewhat unusual step of developing a missile with its own funds as a candidate for the Army's new family of battlefield missiles. Work was started in July, and test firings were made at Redstone Arsenal early this year. The missile is powered by an Astrodyne solid rocket motor, rather than the Rocketdyne powerplant reported earlier.

Chance Vought built the missile with its own money to reinforce its bid because this was its first substantial sales effort with the Army, and the company wanted to make an impact beyond the usual bidding process.

Some commercial business is also considered desirable, although the company has set no definite goals or deadlines. Detweiler told AVIATION WEEK that "success is our aim," and Chance Vought will feel its way along to this goal in the commercial field, settling for whatever mix of military-commercial business develops.

Detweiler expects commercial business to be in keeping with the company's capabilities, and this means products which are fairly complex technically. No consumer products are

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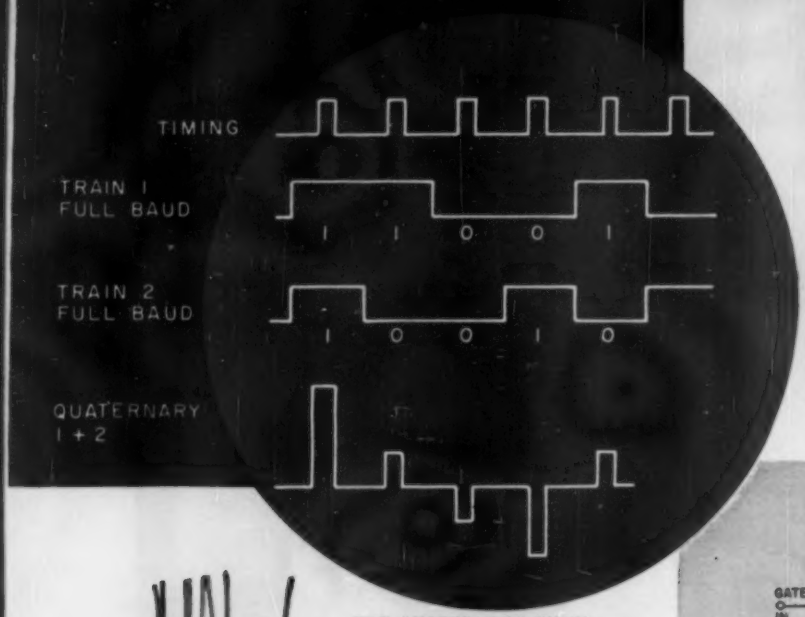
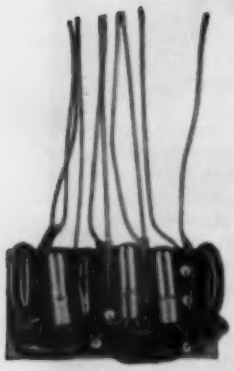
PULSE CODE MODULATION

PCM is a new method of coding voice and analog information into digital form. It provides a completely digitalized message by time-division multiplexing of voice circuits. Adaptation of the technique offers advantages in signal-to-noise characteristics, signal regeneration, message security and equipment reliability not usually achieved with conventional techniques.

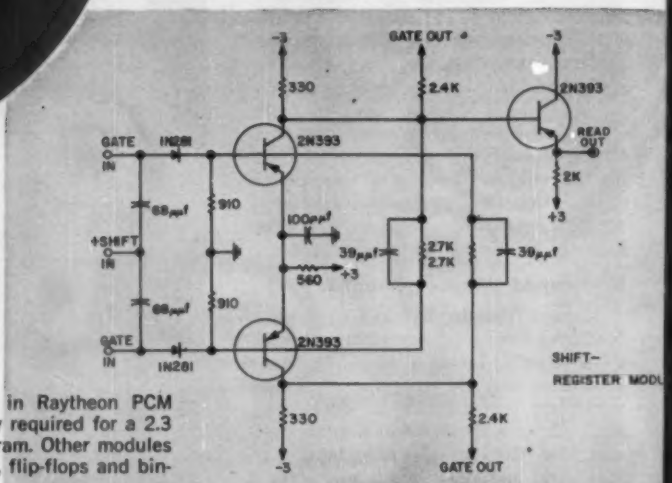
A 96-voice channel, fully transistorized PCM equipment for cable and radio transmission meeting rugged military requirements is now being developed by the Communications Department of Raytheon's Government Equipment Division. In this system a sampling frequency of 8,000 cycles is used. Each sample is coded in six-bit binary form, at a bit frequency of 4.6 mc. Many new circuit techniques, closely allied to high-speed data processing and computer systems are being developed for this equipment.



THE QUATERNARY WAVE combines information from trains 1 and 2, and the timing pulse regulates the width and position of the quaternary output wave. Thus, twice as much information is passed through the same bandwidth as is required for one train.



TYPICAL MOLDED MODULE used in Raytheon PCM equipment comprises logic circuitry required for a 2.3 mc shift register shown in the diagram. Other modules are used for repetitive and-or gates, flip-flops and binary-storage elements.



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contemplated in all these efforts at expansion. Vought is interested in any mergers or acquisitions which might develop naturally, but Detweiler excludes prospects of mergers or acquisition just for the sake of expansion.

A good example of the kind of commercial business that will probably emerge from the diversification effort is the Genesys Corp., a wholly owned subsidiary set up in Los Angeles last year. Genesys will concentrate on the automation market and will design, develop and build advanced computer control systems, components and allied products for commercial applications.

Genesys has joined Sun Oil Co. in a development program for a new automation system for the petroleum company's Marcus Hook refinery in Pennsylvania. Under the new Chance Vought management organization, Gifford Johnson directs these efforts as president of Genesys in addition to his business planning with Chance Vought.

Viewing the company's future, Detweiler sums it up in three segments:

• **Short range,** Chance Vought is trying to make maximum use of team associations in new proposals and to capitalize on Regulus experience in developing the range systems market. The company will make the most of subcontracting prospects in airframe work, plus the design and tooling work involved in such projects as the B-70 program and the ground support and checkout equipment subcontracted by other companies.

• **Medium range,** Chance Vought expects to harvest results from team efforts on systems, to benefit from exploratory work in the anti-submarine warfare field and to get some business in the field weapons area with something like the Army missile.

• **Over the long range,** Chance Vought plans to build a future in astronautics, nuclear and commercial fields. In astronautics Detweiler feels the company is best oriented to emphasize the manned part of future systems. He points to pioneering work now being done on the Dyna-Soar to demonstrate Chance Vought's capability in human factors work.

Temco to Make Layoffs As Airframe Work Drops

Temco Aircraft Corp. will be laying off 2,000 employes in the first half of 1959 because of dwindling airframe subcontracts. In spite of layoffs in January and February, Temco employment has recently risen to about 8,250, largely due to a major expansion of KC-97 maintenance and electronic work. This expansion is about finished and employment will decline to a level of about 6,800 by mid-year.

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WHO'S WHERE

(*Continued from page 23*)

Changes

Robert F. Garbarini, director of engineering and sales, Sperry Gyroscope Co.'s Air Armament Division, Great Neck, N. Y. Other Air Armament appointments are: **Gerald B. Wright,** manager-customer relations; **John R. Ericson,** engineering manager-Hustler; **Robert L. Wendt,** manager, sales and subcontracts-Hustler.

Charles E. O'Hollaren, manager-operations planning and control, Summers Gyroscope Co., Santa Monica, Calif.

Eugene L. Klein, manager-customer relations department, Marquardt Aircraft Co.'s Ogden, Utah, Division.

Jack Gray, senior contract administrator, Temco Aircraft Corp., Dallas, Tex., succeeding **Howard Clark,** now business manager on the Corvus missile program.

Keith G. Britton, assistant to the vice president of the Project Engineering Division and the West Coast affiliate, U. S. Flare, of Atlantic Research Corp., Alexandria, Va.

Emil F. Gibian, director of industrial engineering, Thompson Ramo Wooldridge, Inc., Cleveland, Ohio.

Richard T. McCauley, general sales manager, Koehler Aircraft Products Co., Inc., Dayton, Ohio.

Albert W. Yates, manager-military transport sales, Canadair Limited, Montreal, Canada. Also: **David W. H. Godfrey,** assistant manager of information services.

Gordon K. Taylor, district manager of the Rome, N. Y., office of the Electronics Division of Stromberg-Carlson, a division of General Dynamics Corp.

Asa Snyder, director of research and development, Clearing Division of U. S. Industries, Inc., Chicago, Ill.

U. Victor Turner, manager of manufacturing, Data-Control Systems, Inc., Danbury, Conn.

John K. Wetherbee, chief, Systems Engineering Division, Battelle Memorial Institute, Columbus, Ohio.

James R. Becker, aviation sales manager, and **Scott H. Hanville, Jr.,** manager, application engineering, Jack & Heintz, Inc., Cleveland, Ohio.

Paul P. Duron, chief engineer, Hydrodyne Corp., Los Angeles, Calif.

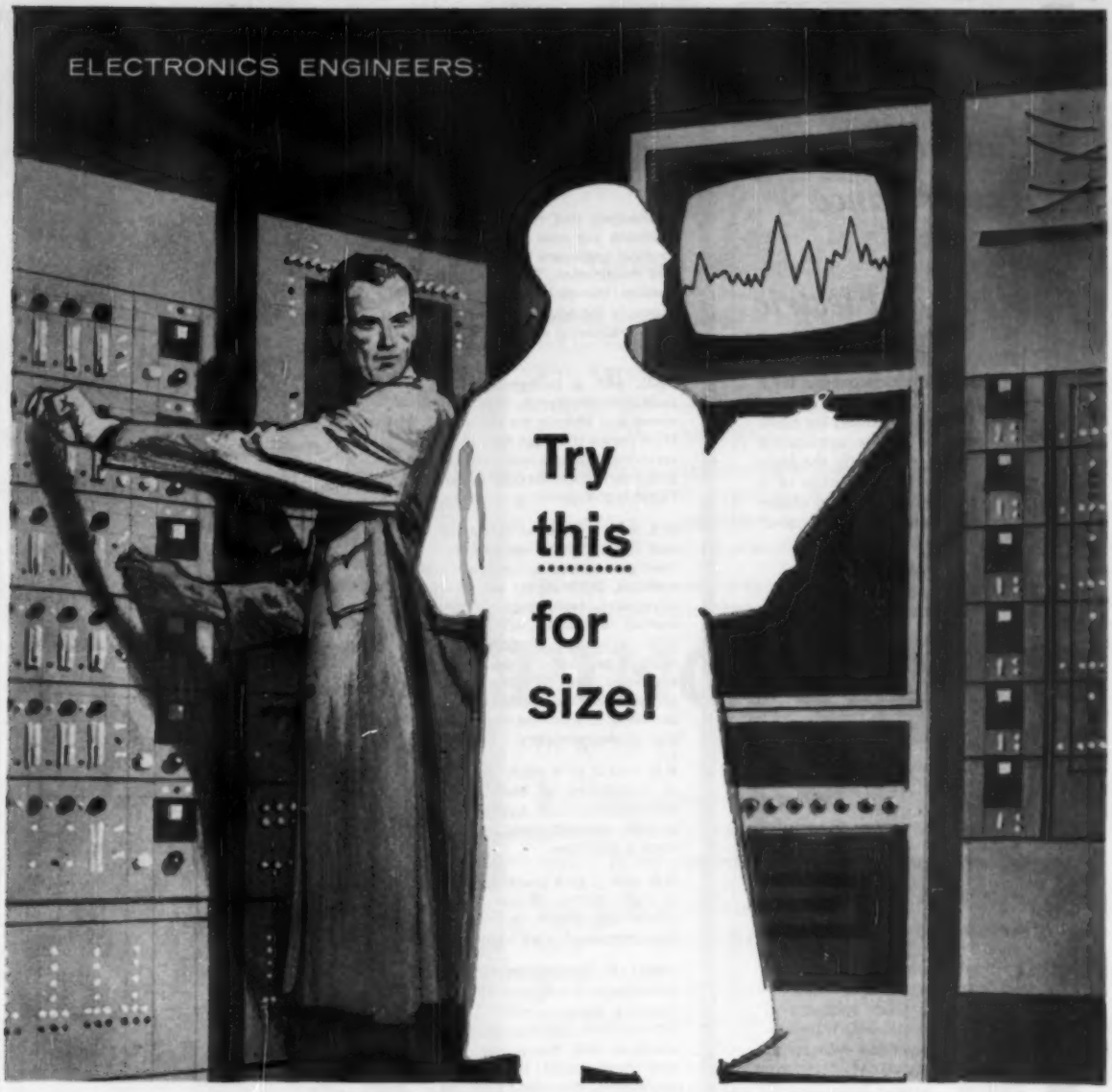
Lt. Col. Donald L. Perry (USAF ret.), director of aero-space development, Charles Luckman Associates, Los Angeles, Calif.

Hugh C. Bream, manager, Santa Barbara Division, Western Design, a division of U. S. Industries, Inc., Santa Barbara, Calif. Also: **Douglas Haville,** senior research engineer; **William S. Dickey,** project manager-underwater detection and telemetering systems programs, and development of special test equipment.

Leo B. Pambrun, corporate director of advertising, Pacific Airmotive Corp., Burbank, Calif.

Walter R. Kuzmin, manager of reliability engineering, and **H. S. Crawford,** purchasing agent, Technical Products Division, Packard-Bell Electronics Corp., Los Angeles.

Dr. Victor Twersky, laboratory consultant, Electronic Defense Laboratory, Sylvania Electric Products, Inc., Mountain View, Calif.



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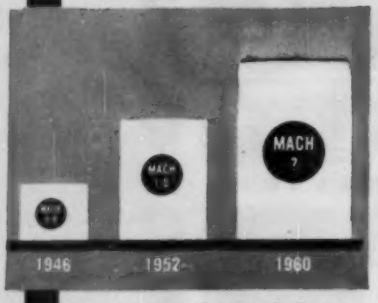

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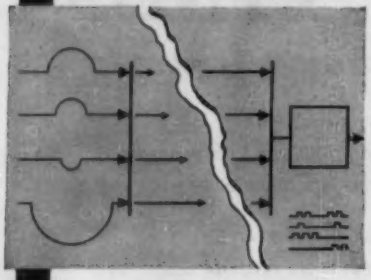
Digital Extraction of Target Signal Information Making Use of Moving Target Characteristics



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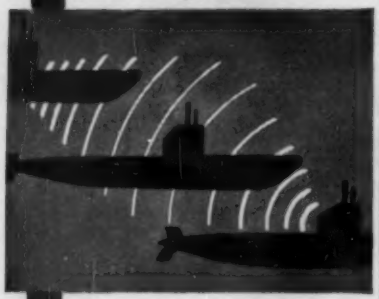

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Some News of Moment to Engineers

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and in ensuing weeks, a group of men—whom the engineering world is beginning to call "scientific generalists"—will sit around a table with representatives of the Air Force, defining the problems and formulating the conceptual bases of an unprecedented DATA PROCESSING SYSTEM. This system will handle *evaluation and distribution of continuing variables on a scale never before attempted* and transcend present potentials in Man-Machine Relationships.

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LETTERS

Improved Defense

I enjoyed your recent editorial "The Familiar Mixture" (AW Feb. 2). As I read it an idea came to me of a way to improve our defense capability with no change in the money allocated, no change in any one company's share of the defense dollar, and the biggest one of all, no major politics involved. This idea is:

Cancel the Titan as an ICBM (it is no better than the Atlas), take all of the Titan ICBM money and put it on Dyna-Soar. Since Martin is one of the prime contractors on this program and they plan on using Titan in their initial phase of the Dyna-Soar program, none of the work already done on Titan will be wasted and Martin won't lose much of the defense dollar they now control. There are many more reasons this looks good, such as the Air Force only having to learn and operated one complicated ICBM, and many other advantages and a few disadvantages which seem rather small compared to the fact we would lose no ICBM capability in the next two years and Dyna-Soar will be advanced as well as the state of the art due to spending more money on a more advanced system than a simple ballistic missile.

Oh yes, your article is like all the others critical and good, but how about some constructive ideas since you obviously have some in mind. Somebody has to lead our "leaders" out of the woods.

TEXAS ENGINEER

Military Planning

Your editorial in the Feb. 2 issue of AVIATION WEEK was excellent. There is one point that needs more emphasis. The military planners are partly to blame because of their inability to choose between competing weapon systems. As a result they are forced by budget pressures into arbitrary choices.

For example, how can we really justify and pay for B-52s, B-58s, air-to-surface missiles, B-70s, Quail, Snark, Atlas, Titan, Minuteman, Polaris, Dyna-Soar, Thor, Jupiter, nuclear bombers, etc., for the strategic mission alone?

We can't afford all these and it would be better for the military planners to accept this as a fact and make choices based on military considerations.

DELBERT W. JONES
Whitesboro, N. Y.

Management Pilots

Even as airline pilots should and usually do give ". . . serious thought and earnest effort to fully discharging their responsibilities to their managements and the traveling public . . .", the editor of AVIATION WEEK should also give serious thought and earnest effort to fully discharging his responsibilities to his readers by providing facts, not deceptive implications and generalizations.

The editorial "Rewards and Responsibility" (AW Feb. 16, p. 21) cites ". . . the case of the Pan American Boeing 707 jet transport that peeled off into a spiral full-power dive . . ." as an indication ". . . that some airline pilots are willing to accept the rewards of their work without fully discharging all of their responsibilities."

It is difficult to believe that one who can so assuredly describe the details of this incident would be unaware of the fact that the pilots involved were not airline pilots but executive or management pilots substituting for the former until a mutually satisfactory contract has been negotiated.

FRED A. ELLIS, M. D.
Seattle, Wash.

(Passengers riding the airlines are concerned with safety of operations in flight, not with the labor or management affiliation of the pilots in the cockpit. Our remarks were directed toward all pilots who participate in airline operations—trunkline, feeder, cargo, and non-scheduled.—Ed.)

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Glowing Altimeters

I think some of the danger inherent in misreading either Kollsman altimeter on approaches (AW Feb. 16, p. 36) could be eliminated by having the altimeter glow green at 3,000 ft., yellow at 2,000 ft., and red at 1,000 ft.

ALBERT SEHLSTEDT, JR.
Baltimore, Md.

Kinloch Field Marker

I would greatly appreciate it should you see your way clear to place in your AVIATION WEEK magazine a few lines along the following subject, so we might get some response from the few living Benoist Plane Co. pilots—names and addresses which no one has. I knew the late Christy Magrath, who died suddenly in November, and he was so saddened that there never was a marker at old Kinloch Field, near St. Louis, Mo., that I have been trying to get ideas and views on the subject from the very few Benoist men I have names of. Magrath, of course, had all their names, etc., but his records are all tied up in court, settling his will, etc.

As you know, Tom Benoist had his school, field, shops, etc. at Kinloch from 1910 to about 1915, when he moved to Sandusky, Ohio, where he was killed in an accident in 1919, after which the company closed up. Many famous flyers received their basic training at Benoist before going over to the Wrights and Curtiss. "Benoist Pilots," a marker for Kinloch Field—please send your ideas.

REGINALD D. WOODCOCK
509 Midvale Rd.
Upper Darby P. O.
Dela. Co., Pa.

Ballistic Ballad

Here is the Cape Canaveral version of Volare (Nel Blu Di Pinto Blu):

Polaris, Oh! Oh!
Polaris, look out below!
Nel blu the Atlas she blew
The Jupiter has troubles too
Yes, these birds they keep shootin,
Accordin to Newton
Whatever goes up has to fall,
And since this is duck season,
Some hunter's the cause of it all.
So if you hear it thunder
Find a bar to dive under—and call:
Polaris, Oh! Oh!
Polaris, look out below!
Nel blu the Atlas she blew
The Vanguard may land hard on you
Nel blu the Titan could too
We're kiddin' we hope it ain't true
Polaris, Oh! Oh!

Writer: Jim Reidy; As sung by: Jerry Cozzi and Blackie Nelson.

BIRD WATCHER
Cocoa Beach, Fla.

Common Sense

After a long parade of airline accidents and a review of the excuses followed almost immediately by airline pilots' reports of near misses with military aircraft, I would very much like to offer some suggestions. It would appear wise for the airlines to accept some constructive criticism then take action to clean their closets, keep their collective mouths shut, and possibly learn something from (super jet type) military, low salaried pilots.

I feel sure the military services would lend advice on how to fly the "Super" B-58, B-52, B-47, F-100 or even the KC-135 (707).

It doesn't require 20,000 hr., super strength, or intelligence to fly these aircraft, but a few landings and some common sense tempered with humility go a long way in maintaining one of the most honored and prized professions.

ROBERT ARNOLD
Capt., USAF
Rantoul, Ill.

XF-103 Nose Gear

Mr. Butz' article "Soviets Design Adjustable Landing Gear," (AW Feb. 9, p. 77) compares the Russian approach to the take-off problem with existing U. S. methods.

To keep the records straight, I would like to inform your readers that the Russian approach in using a variable nose gear is similar to one used on the Republic XF-103 in 1954. The major difference between the two approaches is that the Republic design has an automatic pneumatic system and, therefore, does not require the pilot to perform any additional duties during takeoff. Furthermore, the Republic system is not mechanical and is, thereby, more reliable and probably cheaper to produce.

ARNOLD J. RUBIN
Levittown, N. Y.

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220,000 psi

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structural design...
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WEIGHT COMPARISON TABLE
in lbs. per 100 pieces

all drawings are shown in actual size

ESNA LH3393 (220,000 psi)	.44	.77	1.20	1.69	2.55
COMPETITIVE Lightest Nut (180,000 psi)	.60	1.00	1.50	2.15	2.82
COMPETITIVE Lightest Nut (220,000 psi)	.95	1.62	2.75	4.25	6.00

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For specific dimensional, design and test data on ESNA's *new*, lightweight, 220,000 psi nut—Type LH3393, write to Dept. S23-425, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.

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*U.S. Patent No. 2,588,372